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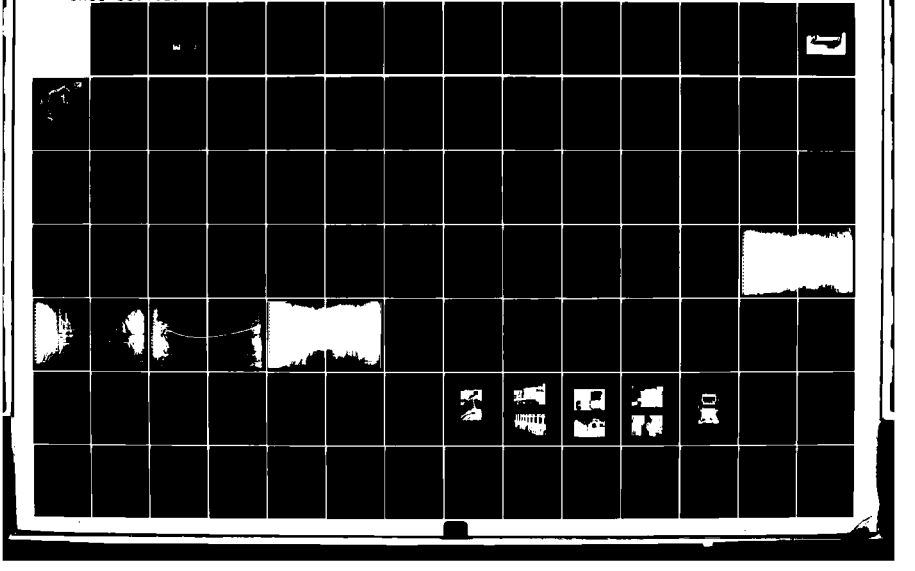

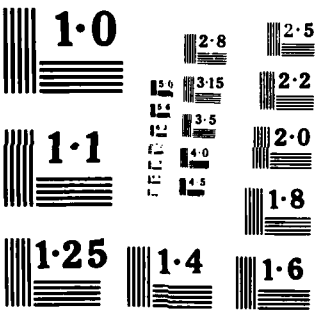
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AD-A156 148

CONNECTICUT RIVER BASIN

STEWARTSTOWN, NEW HAMPSHIRE

LOWER DAM

NH 00129

NHWRB 222.01

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Stewartstown, New Hampshire
Connecticut River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a concrete gravity structure which extends across the entire width of the river and is founded on bedrock. It is 345 ft. long and 27 ft. high. It is small in size with a high hazard classification. The dam is in fair condition. Further investigations are recommended to evaluate the hydraulic and hydrological conditions effecting the dam.

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REPLY TO
ATTENTION OF:
NEDED

MAR 05 1981

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Lower Dam (NH-00129) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Public Service Company of New Hampshire, Chocorua, New Hampshire 03817.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

C. F. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

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As stated

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NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.:	NH 00129
NHWRB No.:	222.01
Name of Dam:	Lower Dam
Town:	Stewartstown
County and State:	Coos County, New Hampshire
Stream:	Connecticut River
Date of Inspection:	June 4, 1980

BRIEF ASSESSMENT

The lower dam (also known as the Canaan Hydro Station) is located on the Connecticut River in Stewartstown, New Hampshire approximately 1/4 mile upstream of West Stewartstown Center. The Lower Dam is a concrete gravity structure which extends across the entire width of the river and is founded on bedrock. It is a total of 345 feet long and 27 feet high. At the left abutment of the dam is a sluiceway 56 feet wide equipped with steel stanchions and wood stoplogs. The invert of this sluiceway is at elevation 1046.0 feet (msl). Adjacent to this is another sluiceway equipped with stoplogs and known as the pulp gate. The pulp gate is 10 feet wide and its invert is at elevation 1051.5 feet (msl). The next section to the right is the main concrete ogee spillway section which is 139.5 feet long and is equipped with 3.5 feet of flashboards. The crest of the spillway without flashboards is at elevation 1051.5 feet (msl). Between the spillway section and the right abutment are two sets of gates. The first is a 20 foot wide sluiceway with a steel Tainter gate and an invert elevation of 1040.75 feet (msl). At the abutment is the head gate which is 12.5 feet wide and 12 feet high and leads to a 9 foot 8 inch diameter wood penstock with an invert elevation of 1040.0 feet (msl).

The dam is owned by the Public Service Company of New Hampshire. It was designed and constructed for hydroelectric power generation. Power is being generated at present. The generator is rated at 1100 kilowatts at 2300 volts.

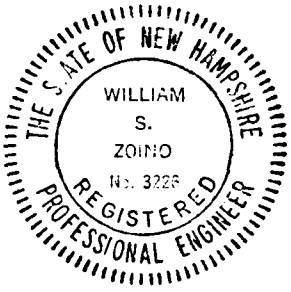
The drainage area of the dam covers 362 square miles and is made up primarily of rolling woodland with some pasture and considerable storage provided by three lakes. The dam has a maximum impoundment of 278 acre feet. The dam is small in size and its hazard classification is HIGH since significant economic loss and potential for loss of more than a few lives could result in the event of a dam failure.

Because of its small size and HIGH hazard classification, the test flood for this dam could range from half the Probable Maximum flood to the Probable Maximum Flood. Since the size classification is on the low side of small, a Test Flood discharge equal to 57,900 cfs (approximately 1/2 PMF) has been adopted as the test flood for this dam. Because there is no attenuation the Test Flood inflow equals the Test Flood outflow. The total spillway capacity of

33,100 cfs indicates that the spillways are capable of passing 57 percent of the adopted test flood. The water surface would be at elevation 1069.1 feet (msl) or 5.1 feet above the top of the dam for this flood.

The dam is in fair condition at the present time. Further investigations are recommended to evaluate the hydraulic and hydrologic conditions effecting the dam, and the effect of the non-failing type flashboards on the structural stability of the dam. Remedial measures to be undertaken by the owner include: implementing annual maintenance and inspection programs, and developing a formal written system for warning the appropriate officials and downstream residents in the event of an emergency.

The recommendations and remedial measures outlined above should be implemented within two years of receipt of this report by the owner.



William S. Zoino
N.H. Registration No. 3226

Nicholas A. Campagna, Jr.
California Registration No. 21006

This Phase I Inspection Report on Lower Dam (NH00129) **has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.**

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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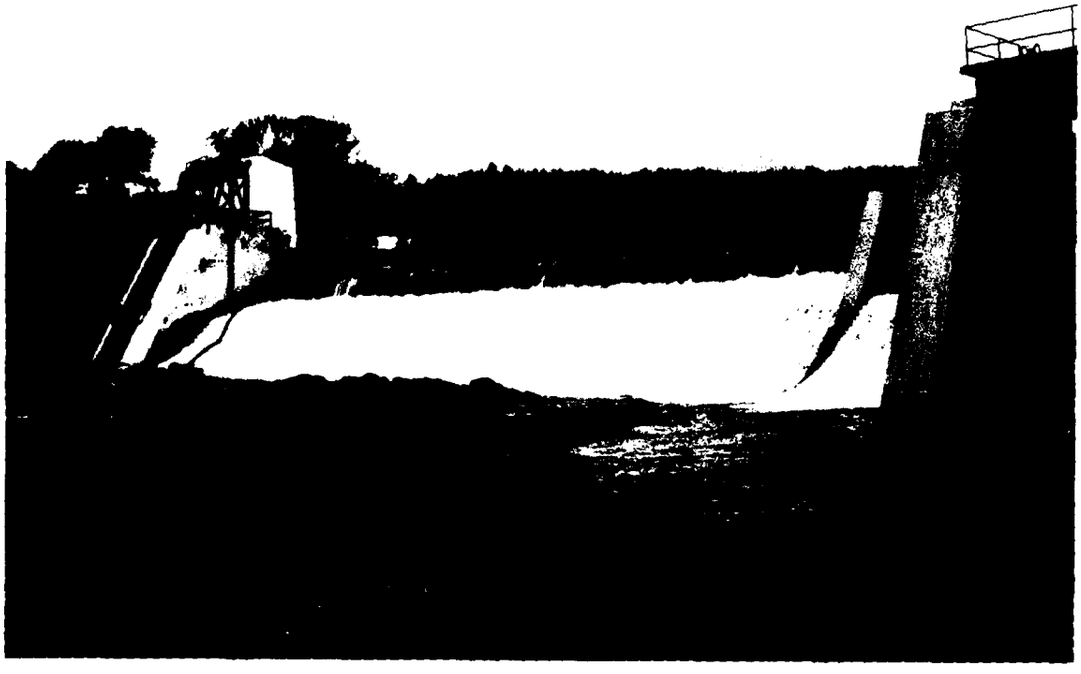
APPENDICES



Overview of Dam

wall and base slab are in good conditon.

The top surface of the sloping training wall located upstream of the forebay entrance has spalled over a length of 2 feet and up to 6 inches deep. Minor cracking and associated efflorescence was also observed on the exposed face of the wall below the spalled area. This localized spalling may be attributed to segregated concrete subjected to moisture intrusion and alternate freeze and thaw cycles.

(c) Reservoir Area (see overview photo)

The reservoir area is the Connecticut River channel. It appears to be stable and in good condition.

(d) Downstream Channel (see overview photo & photo 3)

The downstream channel is the Connecticut River channel. It appears to be stable and in good condition.

3.2 Evaluation

The dam and its appurtenant structures are generally in good condition. The only problem areas noted during the visual inspection were the spalled concrete on the head gate structure and the right abutment, and the non-failing type flashboards.

The gate and operating mechanism (gearing and shafting) was manufactured by Rodney Hunt Company with the electrical operating capability feature added by the operating personnel after the initial installation. Electrical operation is accomplished through a 220 volt, single phase, 1800 rpm, reversible motor with appropriate gear reduction through pulleys and belt drives to the main horizontal drive shaft of the gate operating mechanism.

The timber gate was completely submerged at the time of the inspection and could not be observed. According to Mr. Richard Morin of Public Service Company it contains "a gate with a gate" which can be used to relieve upstream and downstream pressures and is operated from a handwheel operated-bench stand mounted on the main gate centerline of a timber guide frame about 18 feet above the operating floor. The size and invert of the smaller gate are unknown.

The open position of the timber gate and water level is critical to the proper operation of the downstream generator and thus is closely monitored and coordinated by the Canaan Hydro Station operating personnel. This is accomplished through a level sensing device (float) with a selsyn motor at the forebay structure which operates via an overhead signal line with a similar selsyn motor at the generator. Through these selsyn motors forebay operation (water level and gate position) are coordinated with generator operation. Heaters are provided at the forebay level and selsyn motor installation to prevent freeze-ups.

The forebay structure is provided with an overhead electrical service with a 200 amp breaker within the structure prior to power distribution and lighting.

Due to the impact of operation of the timber gate on the downstream generating facilities at the Canaan Hydro Station it was impractical to operate this gate. Mr. Richard Morin of Public Service Company who accompanied the inspection team assured us this gate was totally operable. Inspection indicated the gate and forebay facilities were being well maintained and that operating personnel were thoroughly familiar with their operation.

With the exception of surface rust the trash rack is in good condition. The cable suspended work platform is also in good condition.

The downstream end of the forebay structure consists of two buttress walls with a connecting vertical wall and a concrete slab at a lower level. The wood staved penstock is located under the slab. The left buttress has been subjected to spalling at its interface with the lower slab and on its top sloping surface. The spalls are up to 3 inches deep. This spalling can be attributed to moisture intrusion subjected to alternate freeze and thaw cycles. Minor cracking and efflorescence was also observed. This condition also occurs at the base of the right buttress. The interconnecting

control box has an overhead electrical service and contains a circuit breaker; gate operating buttons (raise, lower, stop and overtravel); controls for three heaters (two sides and bottom of gate to prevent freezing); and an audible alarm to warn of gate opening.

The gate operating drive motor is 5 hp., 220 volt, 3 phase and drives the cable drums located over the sides of the gate and which in turn raise or lower the gate.

Stop log grooves are provided upstream of the Tainter gate. These have been provided for use during maintenance of the gate.

The Tainter gate was opened about 1 foot through the operation of the electrical controls contained in the gate control box and remained in this position for about 15 minutes. The opening was limited to this height to reduce downstream problems. It was obvious the gate is very effective in that the upstream pond level lowered very quickly. At the end of this test the gate was closed. The structural steel supports are in good condition.

The buttress adjacent to the spillway is 8.5 feet wide and with a 2 to 1 sloping downstream face. The top of this buttress is approximately 13 feet above the spillway crest. With the exception of minor surface cracking of a mortar application, this buttress is in good condition. The configuration of the right buttress is similar to the left with the exception that it is 3 feet wide. This buttress also exhibits minor surface cracking. Subsequent to the installation of the gate, approximately 10 foot square steel plates were installed on the interior faces of the buttresses adjacent to the gate in order to preclude cavitation. With the exception of minor surface rust, these plates are in good condition. The concrete paved invert has been subjected to minor surface erosion which can be attributed to cavitation.

6) Head Gate and Penstock Section (See photos 4,5,6,7)

The forebay structure located on the right bank permits the discharge of the impounded water through a gated, 9 ft. - 8 in. I.D. penstock to the downstream Canaan Hydro Station. The superstructure of the forebay is a two story wood frame building and the substructure is of concrete. An 18 ft. wide steel trash rack is located in the upstream portion of the forebay with the top located about 12 in. above the normal pool level. The trash rack is serviced from a timber access platform which is cable supported from the forebay structure.

The 18 ft. wide forebay inlet tapers to the penstock with a 13 ft. wide, 10 in. thick, timber gate controlling or regulating the flow in the penstock. The timber gate can be either manually or electrically operated and moves vertically approximately 11 ft. from the totally open to closed positions.

3) Pulp Gate Structure (See photo 2)

This structure consists of two buttress walls with stoplog slots. The slots are reinforced with steel angles. Six inch stoplogs are set in place up to the top of the spillway flashboards. The stoplogs are in good condition. The surface of both buttresses have received a surface treatment similar to the left abutment. With the exception of random cracking of the surface finish on their upstream faces, these structural components are in good condition.

4) Principal Spillway Section (See phote 1)

This structure is a concrete ogee spillway equipped with flashboards. The flashboards consist of fabricated wood panels 60 inches long and 42 inches high and 1 inch roughsawn stock. The 2 inch stanchions are located approximately 18 inches on centers and are socketed into the concrete for a depth of 7 inches. The flashboards and stanchions are in good condition. A reserve supply of flashboards and stanchions is available in a storehouse located on the right bank. These flashboards are of the non-failing type and may effect the stability of the dam.

Steel assemblies are anchored to the crest and the downstream face for a formerly planned retractable flashboard system which was not installed.

Observations of the downstream face of the spillway revealed that it is in good condition. Surface erosion on this face is periodically repaired with either a high strength Portland cement or epoxy mortar. The concrete apron is random in length either terminating at rock outcrops or terminated in a random configuration.

At the time of inspection the water level of the impoundment pool was at the top of flashboards. At the inspection team's request, the owner's representative operated the Tainter gate in order to lower the impoundment pool in order to visually inspect the downstream face of the spillway. It was estimated that after the gate was opened to one tenth of its maximum opening, the pool was drawn down in excess of 18 inches in a period of 16 minutes.

5) Waste Gate Section (See photo 4,5,8)

The waste gate consists of a typical steel, 20 feet wide, Tainter gate installation operated through an electrical cable drum hoist system mounted on a column-supported, steel framework operating platform. The operating mechanism was manufactured by the Portland Company, Portland, Maine. The structural steel supports are founded on two buttresses. The maximum gate opening is unknown but information contained in Appendix B indicates it is at least 20 feet.

Operation of the Tainter gate is from a control box mounted on the northwest support column of the operating platform. This

Section 3: Visual Observations

3.1 Findings

(a) General

The Lower Dam is in GOOD condition at the present time.

(b) Dam

1) Left Abutment

This structure consists of a training wall which is approximately 213 feet long. It begins at a railroad bridge abutment 103 feet upstream of the stoplog section and extends approximately 100 feet downstream of the stoplog bay. The exposed surface of this wall has received a trowelled-on application of hydraulic cement or high strength mortar. Minor cracking and surface spalling was observed over the wall face with a small amount of efflorescence. Minor honeycombing was observed at the location of three vertical construction joints on the downstream portion of this wall.

2) Stanchion and Stoplog Section (See photo 2)

This structure consists of 12 openings with intermediate 12" x 12" retractable column stanchions. Stoplog slots are cast into the left end wall and the left side of the pulp gate buttress. The stanchions have been subjected to minor surface rust below the stoplog crest elevation. The 6-inch stoplogs are in fair condition, however, seepage through the adjacent logs is in the range of 200 g.p.m. A representative of the owner indicated that the stoplogs are scheduled for replacement during the summer of 1980.

The outlet of the stoplog bay consists of a concrete ogee spillway. With the exception of a continuous open horizontal construction joint, this structure is in good condition. This joint is located on the downstream side of the weir approximately 2 feet below the sill and is 6 inches in depth. The downstream apron is irregular in pattern. In some instances it is constructed around rock outcrops and then for no particular reason it was constructed in a random configuration.

A 10 foot wide footbridge spans over the stoplog structure. This footbridge consists of two reveted steel girders supporting a reinforced concrete slab and piperail fence. The footbridge and its component parts are in good condition.

Section 2: Engineering Data

2.1 Design Data

Four of the design drawings for this dam have been included in this report on pages B-15 through B-18. These do not represent "As-Built" drawings since significant differences exist between the drawings and the dam. In particular, the elevations and dimensions shown do not necessarily match those at the dam.

2.2 Construction Records

No construction records are available for this dam.

2.3 Operational Records

Records of daily operation of the power plant are kept by the Public Service Company of New Hampshire.

2.4 Evaluation of Data

(a) Availability

The lack of detailed design and construction data warrants an unsatisfactory assessment for availability.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment of the dam is based primarily on the visual inspection, past performance and sound engineering judgement.

(c) Validity

Since the observations of the inspection team generally confirm the information contained in the records of the New Hampshire Water Resources Board (with the exception of the previously discussed drawings), a satisfactory evaluation for validity is indicated.

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(j) Regulating Outlets

The regulating outlet is a 20 foot wide sluiceway equipped with a Tainter gate and an electrically operated hoist. The invert of this wasteway is at elevation 1040.75 feet (msl).

(f) Reservoir Surface (acres)

This is a run of the river dam. For analysis purposes, assume 15 acres.

(g) Dam

1) Type: Gravity, overflow, concrete ogee

2) Length: Approximately 345 feet

3) Height: Approximately 27 feet

4) Top width: Variable, 1 to 4 feet

5) Side slopes: Not applicable

6) Zoning: Not applicable

7) Impervious core: Not applicable

8) Cutoff: Unknown

9) Grout curtain: Unknown

(h) Diversion and Regulating Tunnel

Not applicable

(i) Spillways

1) Type: Concrete ogee, overflow, gravity

2) Length of weir:

Spillway section:	139.5 feet
Stanchion section:	56 feet
Pulp gate section:	10 feet

3) Crest elevation: 1051.5 feet (msl)

4) Gates: 20 foot wide wasteway equipped with Tainter gate

5) Upstream channel: Connecticut river channel

6) Downstream channel: Connecticut river channel

9) Total Project Discharge at Test Flood Elevation

The total project discharge at test flood elevation (1069.1 feet msl) is 57,920 cfs.

(c) Elevation (feet above msl)

1) Streambed at toe of dam: approximately 1037.0

2) Bottom of cutoff: Unknown

3) Maximum tailwater: Unknown

4) Recreation Pool: Approximately 1055.0

5) Full flood control pool: Not applicable

6) Spillway crest: Without flashboards: 1051.5
With flashboards: 1055.0

7) Design surcharge: Unknown, 1064.0 according to drawing on page B-15.

8) Top of dam: 1064.0

9) Test flood surcharge: 1069.1

(d) Reservoir (length in feet)

This is a run of the river dam. For analysis purposes, assume 1,000 feet.

(e) Storage (acre-feet)

1) Normal pool: 90

2) Flood control pool: Not applicable

3) Spillway crest pool: 90

4) Top of dam pool: 278

5) Test flood pool: 354

the First and Second Connecticut Lakes and Lake Francis which are located within the watershed.

(b) Discharge at Dam Site

1) Outlet Works

The outlet conduit consists of a 9 foot 8 inch diameter wood penstock controlled by a sluice gate. The invert of the penstock is at elevation 1040.0 feet (msl) and its discharge capacity is approximately 550 cfs.

2) Maximum Known Flood

No data of flow or stage are available for this dam.

3) Ungated Spillway Capacity at Top of Dam

The ungated discharge with the reservoir at top of dam elevation (1064.0 feet msl) is 25,420 cfs. The discharge is broken down as follows: stanchion section, 3,420 cfs; spillway and pulp gate (without flashboards), 22,000 cfs.

4) Ungated Spillway Capacity at Test Flood

The ungated discharge with the reservoir at test flood elevation (1069.1 feet msl) is 43,720 cfs. The discharge is broken down as follows: stanchion section, 7,000 cfs; spillway and pulp gate (without flashboards), 36,720 cfs.

5) Gated Spillway Capacity at Normal Pool

The discharge capacity of the Tainter gate with the reservoir at normal pool elevation (1055.0 feet msl) and the gate free of the water surface is 3,350 cfs.

6) Gated Spillway Capacity at Test Flood

The discharge capacity of the Tainter gate with the reservoir at test flood elevation (1069.1 feet msl) is 9,480 cfs.

7) Total Spillway Capacity at Test Flood

The total spillway capacity at test flood elevation (1069.1 feet msl) is 53,200 cfs.

8) Total Project Discharge at Top of Dam

The total project discharge at top of dam elevation (1064.0 feet msl) is 33,100 cfs.

(c) Size Classification

The dam's maximum impoundment of 190 acre feet and height of 27 feet place it in the SMALL size category according to the Corps of Engineer's Recommended Guidelines.

(d) Hazard Potential Classification

The hazard potential classification for this dam is HIGH because of the significant economic losses and potential for loss of more than a few lives downstream in the event of dam failure. Section 5 of this report presents more detailed discussion of the hazard potential.

(e) Ownership

The dam is owned by the Public Service Company of New Hampshire, Route 16, Chocorua, New Hampshire 03817. The owner's representative, Mr. Link Berry, can be reached by telephone at (603) 323-8505.

(f) Operator

The operation of the dam is controlled by the owner. The owner's representative, Mr. Link Berry, can be reached by telephone at (603) 323-8505.

(g) Purpose of the Dam

The purpose of the dam is to impound water for hydroelectic power generation.

(h) Design and Construction History

The original design and date of construction are unknown. According to records of the New Hampshire Water Resources Board, the dam was rebuilt in 1943.

(i) Normal Operating Procedure

The dam is operated to provide storage for hydroelectric power generation.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for this dam covers 362 square miles. It is made up of rolling woodland and pasture with considerable storage provided by

(b) Description of Dam and Appurtenances

The Lower Dam is a concrete ogee gravity structure which extends across the entire width of the river and is founded on bedrock. It is a total of 345 feet long and 27 feet high. There are five outlets at this dam including three wasteways, one penstock and the principal spillway. These structures are described in the following paragraphs.

1) Stoplog Bay (See pages B-2, B-5, and B-7)

At the left abutment is a 56 foot wide stoplog bay with 12 inch wide stanchions spaced at 4 feet 8 inches center to center. The invert of the sluiceway is at elevation 1046.0 feet (msl). The stanchions are equipped with 5 feet of non removable stoplogs. There is a 4.7 foot high removable panel above the stoplogs. The top of this panel is at elevation 1055.7 feet (msl). (see page B-15) At the top of the stanchion structure is a winch and cable arrangement to facilitate the removal of the panels. The individual stanchions can be raised by means of a manually operated winch and cable system. The cable is strung through a pulley located at the downstream side of the foot bridge opposite the stanchion. The cable is then attached to an eyelet at the top of the stanchion. The stanchion rotates around a pinned connection at the foot bridge level.

2) Pulp Gate (See pages B-2, B-7, and B-8)

To the right of the stoplog bay is a 10 foot wide pulp gate with an invert elevation of 1051.5 feet (msl). This section is slotted for stoplogs and there were 3.5 feet of stoplogs in place at the time of inspection.

3) Principal Spillway (See pages B-2, B-7, and B-8)

The principal spillway is a concrete ogee section, 139.5 feet long, equipped with 3.5 feet of flashboards. The crest elevation without flashboards is 1051.5 feet (msl).

4) Waste Gate (See pages B-2, B-4, and B-11)

To the right of the principal spillway is a 20 foot wide sluiceway equipped with an electrically operated Tainter gate which is 14 feet high. The invert of the opening is at elevation 1040.75 feet (msl). According to the information contained on pages B-4 and B-12, the gate is capable of at least a 20 foot opening. The maximum gate opening in unknown.

5) Head Gate and Penstock (See pages B-2 and B-6)

At the right abutment is a gate house with a 12.5 feet wide by 12 feet high by 10 inches thick, electrically operated, timber sluice gate leading to a 9 foot 8 inch diameter wood penstock. The invert of the penstock at its upstream end is at elevation 1040.0 feet (msl).

National Dam Inspection Program

Phase I Inspection Report

Lower Dam

Section I: Project Information

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg-Zoino & Associates, Inc. (GZA) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to GZA under a letter of April 17, 1980 from Colonel William E. Hodgson, Jr., Corps of Engineers. Contract No. DACW 33-80-C-0055 has been assigned by the Corps of Engineers for this work.

(b) Purpose

1) Perform technical inspections and evaluations of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

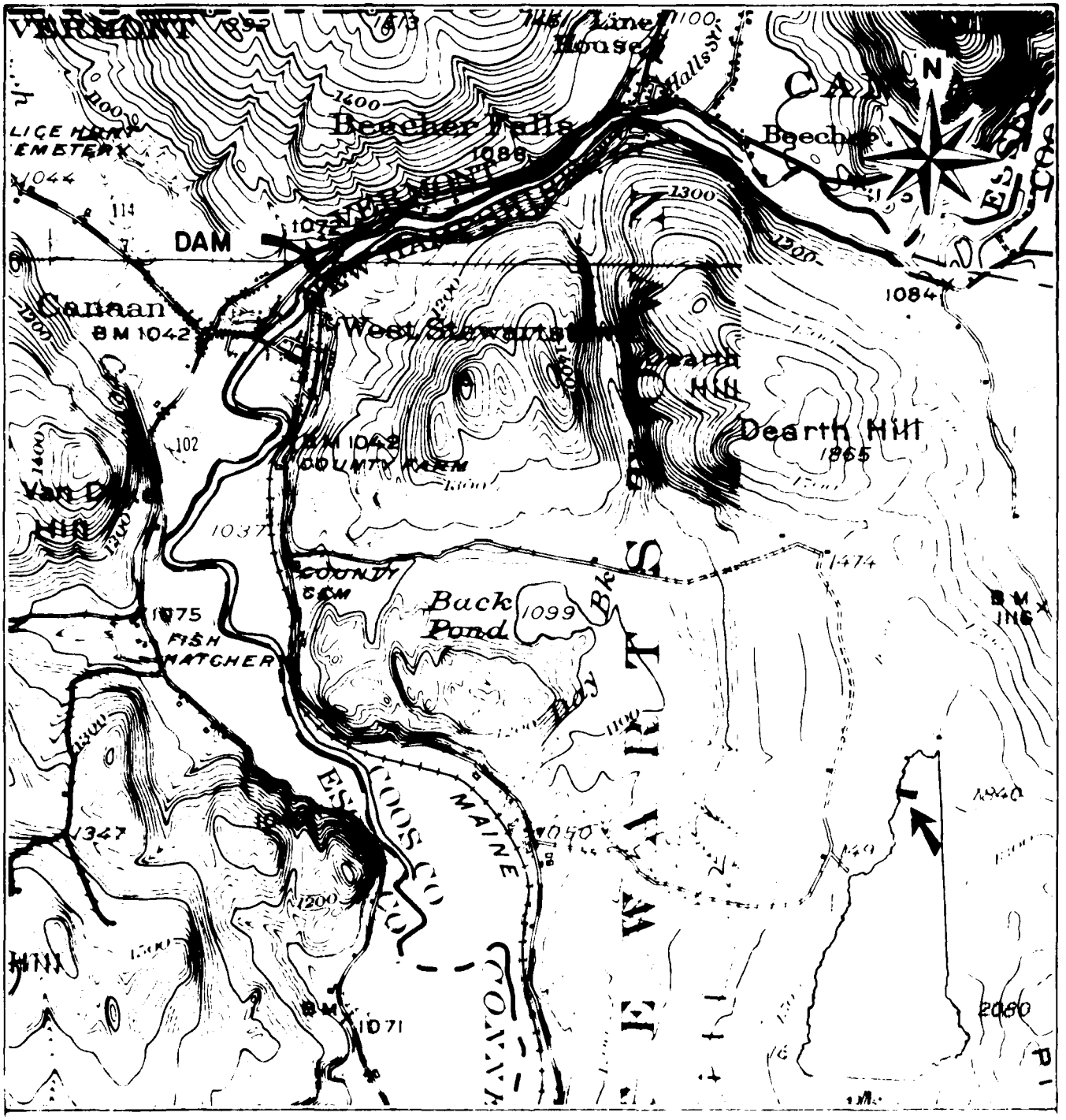
2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

3) Update, verify, and complete the National Inventory of Dams.

1.2 Description of Dam

(a) Location

The Lower Dam is located on the Connecticut River in Stewartstown, New Hampshire, approximately 1/4 mile upstream of West Stewartstown Center. It can be reached from U.S. Route 3 in Stewartstown or from a town road which intersects State Route 114 in Canaan, Vermont. The dam is shown on USGS Haverhill, N.H.-Vermont quadrangle at approximate coordinates N4559.9, W7131.9 (see location map on Page vi).



0 1/4 1/2 (MILE)

FROM USGS AVERILL-VT, NH ; INDIAN STREAM-NH & DIXVILLE-NH QUADRANGLE MAPS

GOLDBERG ZOINO & ASSOCIATES, INC GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS, MASSACHUSETTS	US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION PLAN

FILE No 2605

LOWER DAM — STEWARTSTOWN, NEW HAMPSHIRE

			SCALE AS SHOWN
			DATE

Section 4: Operational and Maintenance Procedures

4.1 Operational Procedures

(a) General

No formal operational procedures exist for this dam. The outlets include the penstock, the waste gate, the pulp gate, the stanchion-section, and the spillway. The facilities are staffed on an as-needed basis in order to maintain the operation of the power plant downstream.

(b) Description of any Warning System in Effect

There is no emergency warning system in effect. There is a horn type warning in conjunction with operation of the waste gate. This serves to warn people who may be in the downstream channel that more water will be coming downstream.

4.2 Maintenance Procedures

(a) General

No written maintenance program exists for the dam. Maintenance is accomplished on an as-needed basis.

(b) Operating Facilities

No written maintenance program exists. Maintenance is performed on an as-needed basis.

4.3 Evaluation

Additional emphasis on routine maintenance will assist the Owner in assuring the long-term safety of the dam and operating facilities. A formal, written, downstream emergency warning system should be developed for this dam.

Section 5: Evaluation of Hydraulic/Hydrologic Features

5.1 General

Lower Dam is a concrete run of the river dam on the Connecticut River. The dam is located about 1,700 feet upstream of the bridge on which Vermont Highway 114 crosses the Connecticut River from Canaan, Vermont to West Stewartstown, New Hampshire. The drainage area of Lower Dam covers 362 square miles of rolling woodland with significant storage available in the First and Second Connecticut Lakes and Lake Francis.

Downstream of the dam, the Connecticut River is very wide between 15-20 foot high banks for the first 1,000 feet. U.S. Route 3, on the east bank, is parallel to, and well above, the stream, as are numerous houses 20-25 feet above the channel. To the west, Vermont State Highway 102 runs along the river, and one house is 14.5 feet above the channel; two houses are 16 feet up, and five to ten houses are 20 or more feet up. The penstock for power generation runs along the river's west bank, generally about 6 feet above the channel bed. The power generation station for the dam is 12 feet above the streambed on the west bank about 1,000 feet downstream of the dam.

From 1,000 to 1,800 feet downstream of the dam, the river is somewhat narrower as it passes through West Stewartstown village. Most of the houses in this reach are more than 20 feet above the stream. Near the downstream end of this reach, 1,700 feet from Lower Dam, is the Vermont State Highway 114 bridge, a truss structure with a 15 foot high by 75 foot wide flow opening. There is a store just upstream of the bridge and two houses just downstream, all about 15 feet above the river channel.

About 100 feet downstream of the Vermont 114 bridge, the river banks become much lower, and the river spreads to extensive flood plains on both sides. In the first 2,000 feet of this reach, there are two to four houses about 12 feet above the channel, and another ten to fifteen less than 20 feet up.

5.2 Design Data

Lower Dam was built in 1943 to replace an existing dam on the same site. Some of the original design work by the New England Public Services Company Engineering Department is available, as is correspondence between the New Hampshire Water Control Commission and the Public Service Company of New Hampshire regarding dam construction. The Public Service Company of New Hampshire provided rating curve information for the dam dated 1955 and 1956. This data is given on pages B-4 through B-14 in this report. A June 13, 1977 inspection report was also available for Lower Dam.

5.3 Experience Data

Although no flow or stage recording devices or data exist at the Lower Dam itself, (drainage area = 362 sq. mi.), three U.S.G.S. recording stations on the Connecticut River provide relevant information as follows:

Gauge	Drainage Area (sq. mi.)	Period of Record	Peak Flow (cfs)	Date
Connecticut River at First Connecticut Lake	83	1917-present	7200	June 16, 1943
Connecticut River below Indian Stream	254	1956-present	4080	November 29, 1959
Connecticut River at North Stratford	799	1930-present	28,700	June 16, 1943

5.4 Test Flood Analysis

The hydrologic conditions of interest in this Phase I investigation are those required to assess the dam's overtopping potential and its ability to safely allow an appropriately large flood to pass. This requires use of the discharge and storage characteristics of the structure to evaluate the impact of an appropriately sized Test Flood. The only hydraulic and hydrologic design analysis available for this dam was some stage-discharge information.

For the purposes of this analysis it was assumed that the penstock is open, the waste gate is fully raised, the flashboards are gone, and the stoplogs and removable panels (of the stanchion section) are still in place. This corresponds to the likely operating procedure in the event of a major storm.

The impoundment of less than 1,000 acre-feet and the height of less than 40 feet classify this dam as a SMALL structure. The appropriate hazard classification for this dam is HIGH because of the significant economic losses and potential for loss of life downstream in the event of failure of the dam. As shown in the Dam Failure Analysis section, the increase in flooding caused by failure would cause property damage to more than ten houses and stores in the communities of Canaan, Vermont and West Stewartstown, New Hampshire, and would present a significant threat of loss of life at some of these houses.

The appropriate Test Flood for a dam classified as SMALL in size with a HIGH hazard potential would be between one-half the Probable Maximum Flood (PMF) and the PMF. Since Lower Dam is at the lower end of the smallsize category, the one-half PMF has been adopted as the appropriate Test Flood.

The large amount of storage in the Connecticut River Basin upstream of the project in the Connecticut Lakes and Lake Francis makes the "Maximum Flood Peak Flow Rates for New England" inapplicable in this case. An estimated one-half PMF for this location is 160 csm, yielding a peak test flood inflow of 57,900 cfs.

The pond behind Lower Dam is so small that the attenuation for flow of this magnitude would be negligible. Therefore, the peak test flood outflow is 57,900 cfs and the peak stage would be about 1069.1 feet msl. This is 17.6

feet above the principal spillway crest, 5.1 feet above the right abutment, and 4.1 feet above the left abutment. The spillway capacity is 57% of the peak test flood discharge.

5.5 Dam Failure Analysis

The peak downstream flows that would result from the failure of Lower Dam are estimated using the procedure suggested in the "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs". The failure is assumed to occur with the water surface elevation at the top of the right abutment, 1064 feet (msl). The outflow prior to dam failure would be 33,100 cfs, creating a tailwater of 16.6 feet in the channel downstream of the dam.

For an assumed breach width equal to 40 percent of the dam width at the half-height, the gap in the embankment due to failure would be about 100 feet. The resulting peak failure outflow would be 56,700 cfs given the 27 foot embankment height. This would increase the tailwater stage from 16.6 feet to 22.4 feet.

The peak failure flow would attenuate to 49,100 cfs in the first 1,000 feet downstream of the dam creating a stage of about 21 feet. Prefailure flows would already subject the penstock and generating station in this reach to damage, while one low-lying house would receive about 2 feet of flooding and two more about one-half foot. Dam failure would increase this to 7 feet and 5 to 6 feet respectively. There would be a threat of loss of life at these houses.

The Connecticut River narrows considerably between 1,000 and 1,800 feet downstream of the dam, and the prefailure flow of 33,100 cfs would create a stage of 25-26 feet which would increase to 29-30 feet after the failure. The increased stage compared to dam failure stage upstream is due to the narrower stream channel. The attenuated peak failure flow would be 44,200 cfs at the downstream end of this reach. Development along the river includes the Vermont State Highway 114 Bridge and 2 houses and a store, all about 15 feet above the stream and near the downstream end of the reach. All would experience severe flooding before dam failure. There are also some 10-20 houses and commercial establishments on both sides of the river 25-30 feet above the river. Many of these structures would be threatened by the dam failure flood wave and its 4-5 foot increase in flooding.

About 1,800 feet downstream of Lower Dam the Connecticut River's banks become lower, with extensive flood plains on either side. The prefailure flow of 33,100 cfs and stage of 19 feet would cause serious flooding at the two to four houses about 12 feet above the channel, and significant flooding at the five to ten houses from 12-20 feet up. Dam failure would increase flooding to about 21 feet at the upstream end of the reach. The peak failure flow of 44,200 cfs and stage of 21 feet would attenuate in the extensive floodplain, but a 1-2 foot increase to flooding could be expected through the developed area. The chart on the next page summarizes the downstream impact of the failure of Lower Dam.

DOWNSTREAM IMPACT OF THE FAILURE OF LOWER DAM

	Location & Number (see map)	Distance Downstream of dam (in ft.)	# of structures	Level above stream (in ft.)	Flow and Stage Before Failure	Flow and Stage After Failure	Comments
	Just below the dam	-	-	-	33,100 cfs 16.6 ft.	56,700 cfs 22 ft.	
	Low houses in first reach	500	1 house 2 houses	14.5 16	33,100 cfs 16.6 ft.	52,900 cfs 22 ft.	Danger of loss of life
	Other houses in first reach	200-1000	3-5 houses	20+	33,100 cfs 16.6 ft.	49,100 to 56,700 cfs 21-22 ft.	Flood damage, slight danger of loss of life
1	Power station	1000	1	12	33,100 cfs 16.6 ft.	49,100 cfs 21 ft.	
	Houses along second reach	1000-1800	5-10 houses	25-30	33,100 cfs 26 ft.	44,200 to 49,100 cfs 29-30 ft.	Damage and danger of loss of life
2	Route 114 bridge	1700	1 store 2 houses 1 bridge	15 15 15	33,100 cfs	45,000 cfs	Probably no additional damage due to dam failure
	Houses below 114	1800-3800	2-4 houses 5-10 houses	12 12-20	33,100 cfs 19.0 ft.	<44,200 cfs 21 ft.	Incremental flood damage only slight chance of loss of life here

Section 6: Structural Stability

6.1 Evaluation of Structural Stability

(a) Visual Observations

Some minor cracking and spalling of concrete were noted at the waste gate and pulp gate buttresses and at the right training wall. No structural deficiencies were noted which would warrant further investigations.

(b) Design and Construction Records

No plans or calculations of value to a stability assessment are available for this dam.

6.2 Design and Construction Data

No records of structural stability analyses are available for this dam.

6.3 Post Construction Changes

The date of the original construction is unknown. The dam was rebuilt in 1943 and there have been no known changes since that time.

6.4 Seismic Stability

The dam is located in seismic zone No. 2 and, in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

Section 7: Assessment, Recommendations and Remedial Measures

7.1 Dam Assessment

(a) Condition

The Lower Dam is in FAIR condition at the present time. This evaluation is based upon the small spillway capacity in relation to the adopted test flood.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgement. The crest of the Tainter gate in its closed position is 3.5 feet above the permanent spillway crest, which is also the top elevation of the flashboards. In view of this, it appears that any prior stability analysis did consider this head condition in the design of the planned retractable flashboard system. This system was never installed.

(c) Urgency

The recommendations and improvements contained herein should be implemented by the owner within two years of receipt of this Phase I report. However, the hydraulic assessment discussed in the following paragraph should be completed within one year of receipt.

7.2 Recommendations

It is recommended that the services of a qualified registered professional engineer be retained for the following:

a. To determine the effect of the existing flashboards in the stability of the spillway and to make recommendations as to whether they should be of the failing type under a specified head of water.

b. To perform a hydraulic and hydrologic assessment of the dam for the purpose of estimating the degree and likelihood of overtopping to which the dam might be subjected.

The owner should implement the findings of these studies.

7.3 Remedial Measures

It is recommeded that the following remedial measures be undertaken by the owner:

(a) Repair all spalled concrete (for example: the waste gate and pulp gate buttresses and the right training wall)

(b) Implement a program of biennial technical inspections of the dam and its appurtenances including operation of all outlet works.

(c) Develop a plan for surveillance of the dam during and immediately after periods of heavy rainfall and for warning downstream officials and residents in the event of an emergency.

(d) Implement and intensify a program of diligent and periodic maintenance.

7.4 Alternatives

There are no meaningful alternatives to the above rocommendations.

Inspection Team Organization

DATE: June 4, 1980

PROJECT: NH 00129
Lower Dam
Stewertstown, New Hampshire
NHWRB No. 222.01

WEATHER: Clear, warm

Inspection Team

Nicholas A. Campagna	Goldberg Zoino & Associates, Inc.	Team Captain
Jeffrey M. Hardin	Goldberg Zoino & Associates, Inc.	Soils
Andrew Christo	Andrew Christo Engineers	Structures
Paul Razgha	Andrew Christo Engineers	Structures
Carl Razgha	Andrew Christo Engineers	Structures
David A. Duncan	Bethel,Duncan & O'Rourke,Inc.	Mechanical & Electrical

Tom Gooch and Richard Laramie of Resource Analysis Inc. performed the hydrologic inspection of this dam on June 11, 1980.

New Hampshire Water Resources Board
Representative Present -- Mr. Pattu Kesavan

LOWER DAM — June 4, 1980

Stewertstown, New Hampshire — NH 00129

CHECKLISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
LEFT ABUTMENT		
Condition of concrete	PR	Good
Erosion		None noted
Spalling		Minor
Cracking		Minor
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Minor
Seepage		None noted
Honeycombs		Minor on 3 vertical construction joints on downstream wall
STOP LOG BAY		
Retractable column stanchions		Subjected to minor surface rust below pool elevation. No other deficiencies noted.
Stop logs		Fair condition, to be replaced this summer.
Seepage		200 g.p.m.
Concrete spillway		
Condition of concrete		Good
Cracking		Open horizontal construction joint, 6" deep. No other deficiencies noted.
Footbridge		Good
PULP GATE		
Condition of concrete	PR	Good

LOWER DAM June 4, 1980

Stewertstown, New Hampshire NH 00129

CHECKLISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
Cracking	PR	Random cracking on upstream face of both buttresses. No other deficiencies noted.
Stop logs		No deficiencies noted.
PRINCIPAL SPILLWAY		
Condition of concrete		Good
Flashboards and stanchions		No deficiencies noted
WASTE GATE		
Gate		No deficiencies noted
Operating mechanisms		No deficiencies noted.
Audible alarm		No deficiencies noted
Structural steel supports		No deficiencies noted
Concrete buttresses		With the exception of minor surface cracking, no other deficiencies noted.
Protective steel side plates		No deficiencies noted
Concrete invert		With the exception of minor surface erosion, no other deficiencies noted
HEAD GATE AND PENSTOCK		
Wood framed structure		No deficiencies noted
Timber sluice gate		Not observed due to submerged condition
Timber gate operation		Not observed due to impact on downstream generator at hydro station.
Operating mechanisms		No deficiencies noted.
Float controls	PR	No deficiencies noted.

LOWER DAM June 4, 1980

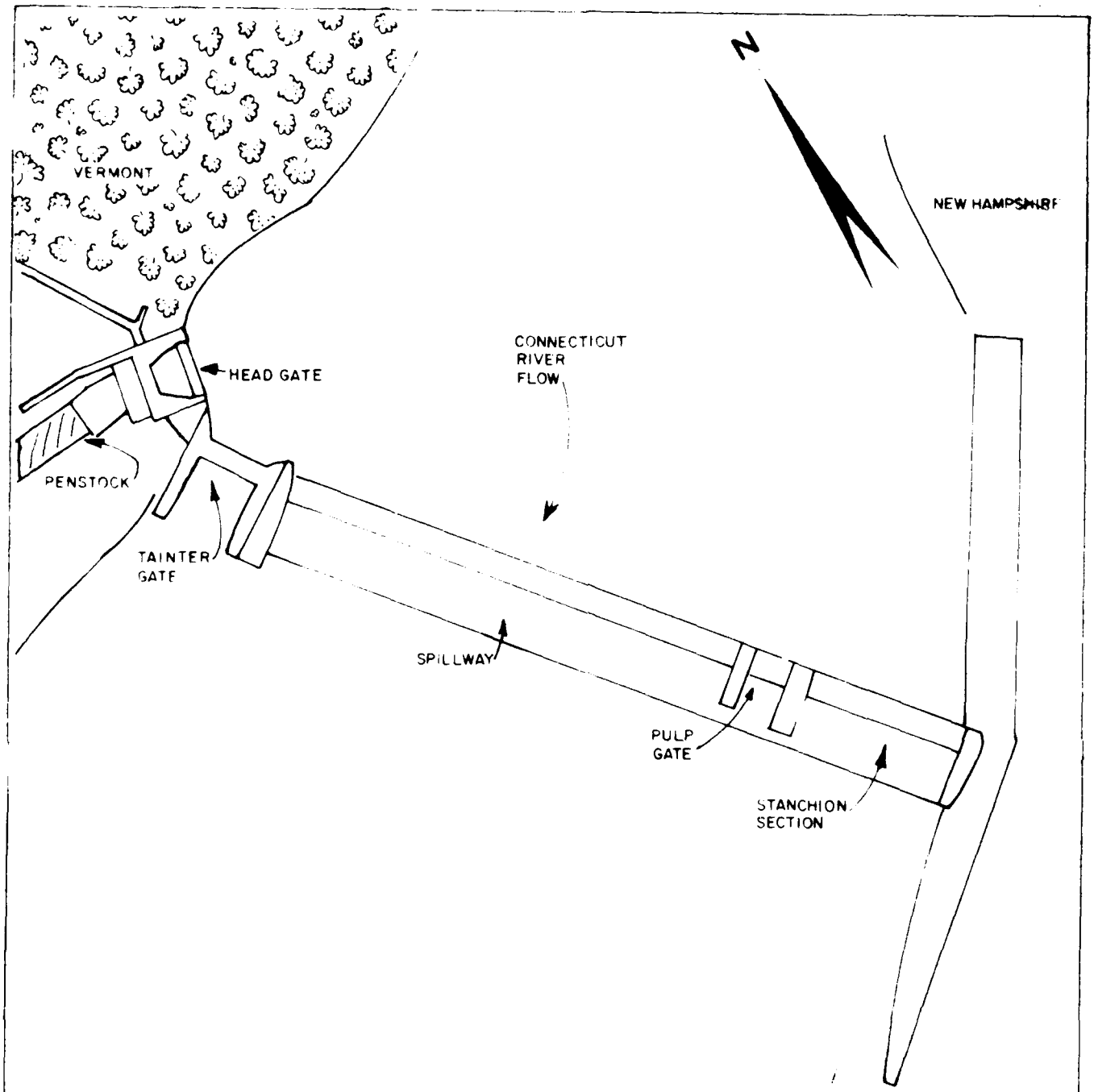
Stewertstown, New Hampshire NH 00129

CHECKLISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
	PR	
Buttresses		
Condition of concrete		Fair
Spalling		Top of walls and interface with slab spalled up to 3 inches.
Erosion		None noted
Cracking		Minor
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Minor
Seepage		None noted
RIGHT UPSTREAM TRAINING WALL		
Condition of concrete		Fair
Spalling		Two feet long and 6 inches deep on top surface
Erosion		None noted
Cracking		None noted
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence	PR	None noted

APPENDIX B

ENGINEERING DATA



GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

US ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SITE PLAN

FILE No 2605

LOWER DAM NEW HAMPSHIRE

SCALE SCHEMATIC

DATE JULY 1980

SITE PLAN

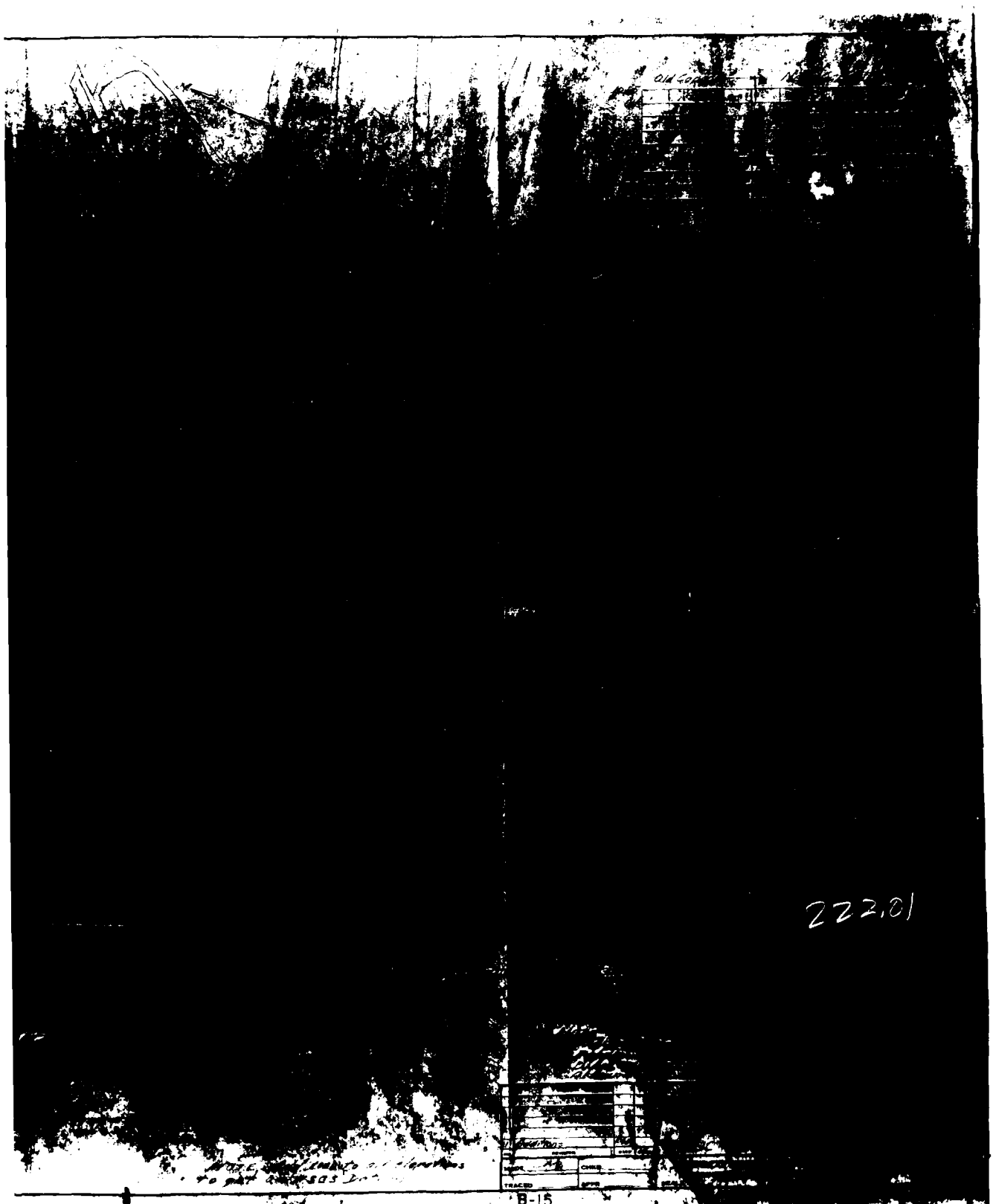
FILE No 2605

LOWER DAM — NEW HAMPSHIRE

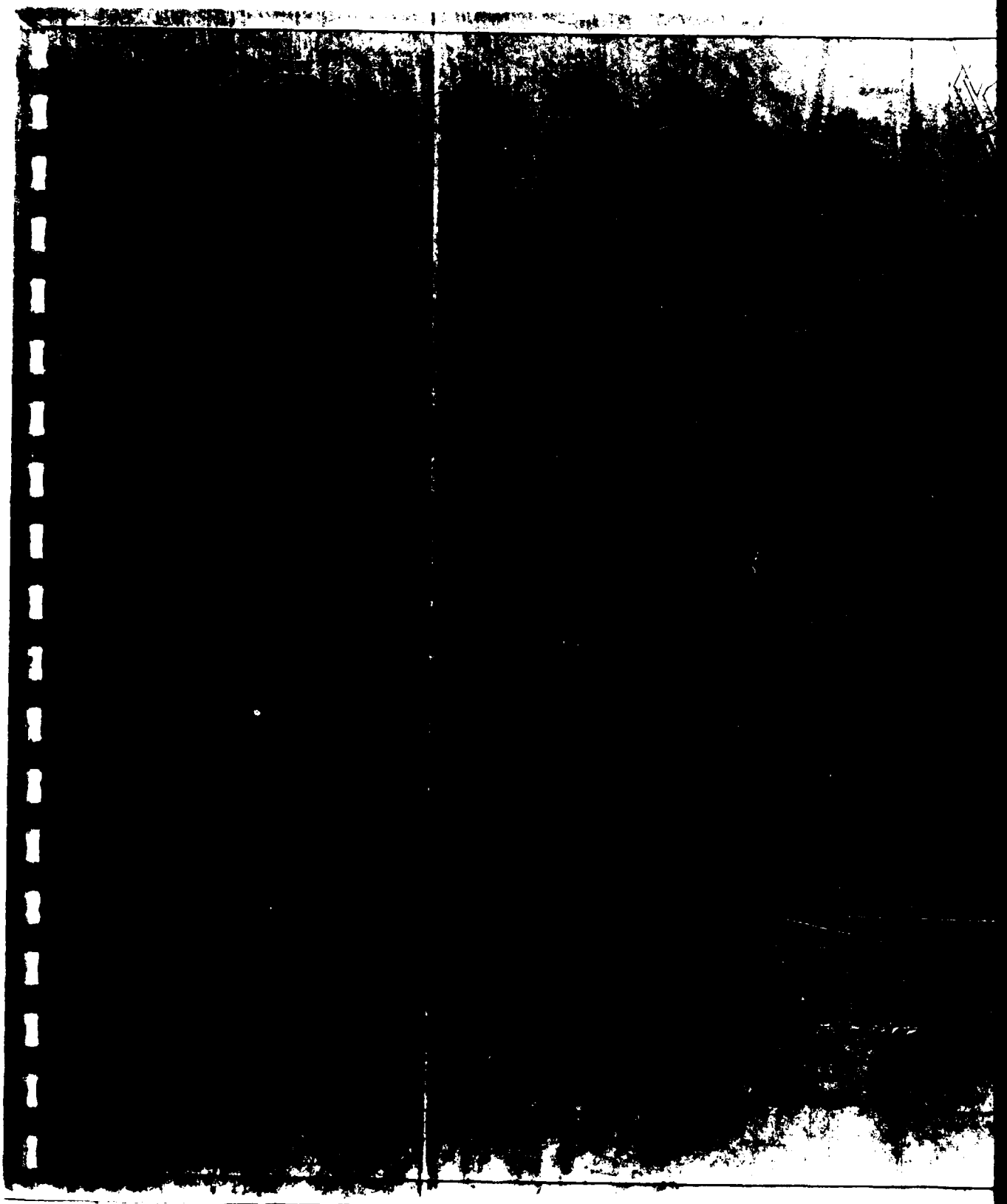
SCALE SCHEMATIC

DATE JULY 1980

B-2



B-15



CANAAN STATION

NOTED JUN 27 1980 L.H.B.

STANCHION SECTION

NOTE: Columns are not removable except by bringing steel columns. Columns pivot on bridge.

Removable panels are 52" wide by 56" high.

B-14

D-6492-

10/10

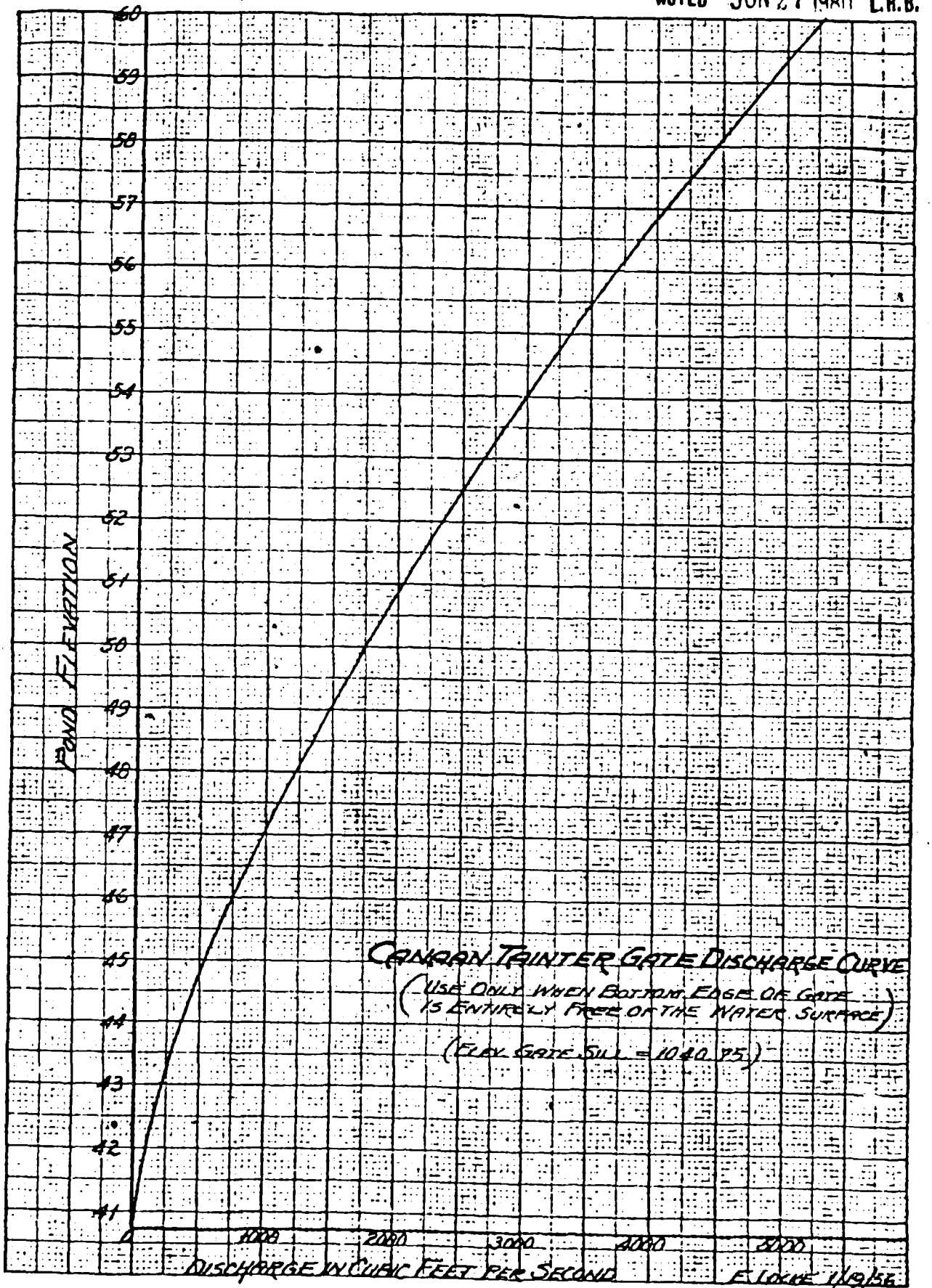
CANNAN STATION

ELEVATIONS AT DAM

NOTED JUN 27 1980 L.H.B.

D-6492-S

NOTED JUN 27 1980 L.R.B.



C-6492-9

NOTED JUN 27 1980 L.R.B.

C-6492-9.2

NOTED JUN 27 1980 L.H.B.

CANAAN HYDRO STATION

DISCHARGE OF STANCHION SECTION - PANELS REMOVED
ALL STOP LOGS IN PLACE
C.F.S

WATER SURFACE ELEVATION	DISCHARGE PER BAY *	DISCHARGE 10 BAYS 35.08' CLEAR	DISCHARGE OVER STOP LOGS 2 EAST BAYS	TOTAL
1051.0	0			
51.6	5	54	-	
51.8	8	84	-	
1052.0	12	117	-	
52.2	15	154	-	
52.4	19	193	-	
52.6	24	236	-	
52.8	28	282	-	
1053.0	33	330	-	
53.2	38	381	-	
53.4	43	434	-	
53.6	49	490	-	
53.8	55	548	-	
1054.0	61	608	-	
54.2	67	668	-	
54.4	73	733	-	
54.6	80	798	-	
54.8	86	866	-	
1055.0	93	899	-	
55.2	100	1002	-	
55.4	108	1078	-	
55.6	115	1152	1	1153
55.8	123	1228	4	1232
1056.0	130	1307	9	1316
56.2	138	1385	15	1400
56.4	146	1467	22	1489
56.6	155	1546	30	1576
56.8	163	1631	39	1670
1057.0	172	1715	48	1763
57.5	193	1933	75	2008
1058.0	216	2165	106	2271
58.5	239	2400	141	2541
1059.0	264	2640	179	2819
59.5	289	2900	221	3121
1060.0	315	3160	264	3424

$Q = 3.33\ LH\ 3/2$
No velocity of approach.
No end contraction for stanchion columns.

* The bay at the west end will discharge 2.4% more than this figure as its clear opening is 3'-7" instead of the 3'-6" for the other 9 bays.

NOTED JUN 27 1980 L.H.S.

CANAAN HYDRO STATION

DISCHARGE OVER BOARDS
All boards in place

Head Water	Main Dam or Pulp Gate per foot of Length	Main Dam 139'-6" Top of Boards 1055.0	Pulp Gate 10'-0½" Top of Boards 1055.0	Stanchion Sect. Top of Panels Elev. 1055.7*	Total
1055.0	0	0	0	0	0
1055.1	.11	15	1	0	16
1055.2	.30	42	3	0	45
1055.3	.55	76	5	0	81
1055.4	.84	118	8	0	126
1055.5	1.18	164	12	0	176
1055.6	1.55	216	15	1	232
1055.7	1.91	266	19	2	287
1055.8	2.38	332	24	8	364
1055.9	2.84	397	29	17	443
1056.0	3.33	464	34	28	526
1056.1	3.84	536	39	42	617
1056.2	4.38	610	44	56	710
1056.3	4.94	690	50	72	812
1056.4	5.52	771	55	89	915
1056.5	6.12	853	61	109	1023
1056.6	6.74	940	67	130	1137
1056.7	7.38	1030	74	152	1256
1056.8	8.05	1123	81	174	1378
1056.9	8.72	1217	88	197	1502
1057.0	9.43	1313	95	221	1629
1057.1	10.12	1413	102	246	1761
1057.2	10.87	1515	109	273	1897
1057.3	11.62	1622	117	300	2039
1057.4	12.38	1728	124	328	2180
1057.5	13.17	1836	132	357	2325
1057.6	13.97	1948	140	387	2475
1057.7	14.78	2065	148	418	2631
1057.8	15.60	2180	157	449	2786
1057.9	16.45	2295	165	481	2941
1058.0	17.30	2415	174	514	3103

$Q = 3.33\ LH^{3/2}$ no velocity of approach
no end contraction for stanchion columns.

*Top of logs in 2 bays at east end = 1055.5.

NOTED JUN 27 1980 L.H.B.

CANAAN HYDRO STATION

DISCHARGE OVER DAM (No Flashboards On)

C F S

WATER SURFACE ELEVATION	HEAD	PER FOOT OF LENGTH	TOTAL MAIN DAM 139' - 6"	TOTAL PULP GATE 10' - 0½"	TOTAL MAIN DAM + PULP GATE
1051.6	.1	.11	15	1	16
1051.8	.3	.55	76	5	81
1052.0	.5	1.18	164	12	176
1052.2	.7	1.91	266	19	285
1052.4	.9	2.84	397	29	426
1052.6	1.1	3.84	536	39	575
1052.8	1.3	4.94	690	50	740
1053.0	1.5	6.12	853	61	914
1053.2	1.7	7.38	1030	74	1104
1053.4	1.9	8.72	1217	88	1305
1053.6	2.1	10.13	1414	102	1516
1053.8	2.3	11.62	1620	117	1737
1054.0	2.5	13.16	1836	132	1968
1054.2	2.7	14.77	2061	148	2209
1054.4	2.9	16.45	2294	165	2459
1054.6	3.1	18.18	2536	182	2718
1054.8	3.3	19.96	2785	200	2985
1055.0	3.5	21.81	3042	219	3261
1055.2	3.7	23.70	3306	238	3544
1055.4	3.9	25.65	3578	257	3835
1055.6	4.1	27.65	3856	278	4134
1055.8	4.3	29.69	4142	298	4440
1056.0	4.5	31.79	4434	319	4753
1056.2	4.7	33.93	4733	341	5074
1056.4	4.9	36.12	5039	363	5402
1056.6	5.1	38.35	5350	385	5735
1056.8	5.3	40.63	5668	407	6075
1057.0	5.5	42.95	5992	431	6423
1057.5	6.0	48.94	6827	491	7318
1058.0	6.5	55.18	7698	554	8252
1058.5	7.0	61.67	8603	619	9222
1059.0	7.5	68.40	9542	686	10228
1059.5	8.0	75.36	10512	757	11269
1060.0	8.5	82.52	11511	828	12339

$Q = 3.33\ LH\ 3/2$.
No velocity of approach.

CANAAN HYDRO STATION NOTED JUN 27 1980 L.R.B.

DISCHARGE OVER BOARDS
All boards in place
C.F.S.

Head Water	Main Dam or Pulp Gate per foot of Length	Main Dam 139'-6" Top of Boards 1055.0	Pulp Gate 10'-0½" Top of Boards 1055.0	Stanchion Sect. Top of Panels Elev. 1055.7*	Total
1055.0	0	0	0	0	0
1055.1	.11	15	1	0	16
1055.2	.30	42	3	0	45
1055.3	.55	76	5	0	81
1055.4	.84	118	8	0	126
1055.5	1.18	164	12	0	176
1055.6	1.55	216	15	1	232
1055.7	1.91	266	19	2	287
1055.8	2.38	~~232~~ 332	24	8	364
1055.9	2.84	397	29	17	443
1056.0	3.33	464	34	28	526
1056.1	3.84	536	39	42	617
1056.2	4.38	610	44	56	710
1056.3	4.94	690	50	72	812
1056.4	5.52	771	55	89	915
1056.5	6.12	853	61	109	1023
1056.6	6.74	940	67	130	1137
1056.7	7.38	1030	74	152	1256
1056.8	8.05	1123	81	174	1378
1056.9	8.72	1217	88	197	1502
1057.0	9.43	1313	95	221	1629
1057.1	10.12	1413	102	246	1761
1057.2	10.87	1515	109	273	1897
1057.3	11.62	1622	117	300	2039
1057.4	12.38	1728	124	328	2180
1057.5	13.17	1836	132	357	2325
1057.6	13.97	1948	140	387	2475
1057.7	14.78	2065	148	418	2631
1057.8	15.60	2180	157	449	2786
1057.9	16.45	2295	165	481	2941
1058.0	17.30	2415	174	514	3103

Q = 3.33 LH 3/2 no velocity of approach
no end contraction for stanchion columns.

*Top of logs in 2 bays at east end = 1055.5.

NOTED JUN 27 1980 L.R.B.

CANAAN HYDRO STATION
DISCHARGE OF WATER WHEEL IN C.F.S.

GENERATOR KW	NET HEAD						
	39'	38'	37'	36'	35'	34'	33'
0	105	110	115	120	125	130	135
100	125	130	135	140	145	150	155
200	146	151	156	161	165	170	175
300	170	175	180	186	191	196	202
400	194	199	204	210	217	224	231
500	218	224	231	237	244	252	260
600	246	253	260	267	274	282	291
700	274	282	290	297	304	314	324
800	304	312	320	329	339	349	359
900	337	344	352	363	374	385	397
1000	374	383	393	403	414	428	442
1100	418	429	440	453	466	482	498
1200	478	495	512	527	542	-	-

From Plan #208-110 N.E.P.S. Co. February 28, 1928

Extended at both ends and interpolated.

CANAAN HYDRO STATION NOTED JUN 27 1980 L.H.B.

STANCHION SECTION DISCHARGE
ALL PANELS, LOGS, AND COLUMNS REMOVED

C F S

WATER SURFACE ELEVATION	WATER SURFACE LENGTH	AVERAGE LENGTH	DISCHARGE PER FOOT OF LENGTH	TOTAL DISCHARGE
1046.0	50.40			
47.0	50.85	50.6	3.32	168
48.0	51.30	50.9	9.43	480
49.0	51.63	51.0	17.3	883
50.0	51.95	51.2	26.7	1365
51.0	52.28	51.3	37.2	1915
52.0	52.60	51.5	48.8	2520
53.0	52.93	51.7	61.8	3190
54.0	53.25	51.8	75.7	3910
55.0	53.58	52.0	90.0	4680
56.0	53.90	52.2	105.4	5490
57.0	54.23	52.3	121.6	6360
58.0	54.55	52.5	153.0	7270
59.0	54.88	52.6	172.8	8200
60.0	55.20	52.8	195.0	9200
1064.0	56.50	53.5	255.0	13640

Q = 3.33 LH 3/2
No velocity of approach.

NOTED JUN 27 1980 L.H.B.

RECEIVED 7/2/80

CANAAN HYDRO STATION
DISCHARGE OF WASTE GATE IN C.F.S.

BOTTOM OF GATE IN WATER

GATE OPEN (FEET)	ELEVATION OF POND WATER SURFACE (U.S.G.S.)														
	1046	1047	1048	1049	105	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060
1	230	250	290	320	340	360	380	390	400	430	460	490	520	540	560
2	420	470	540	590	650	670	720	770	790	840	900	950	990	1010	1040
3	550	640	750	820	910	950	1010	1100	1150	1210	1270	1350	1400	1430	1460
4	650	760	910	1010	1130	1180	1280	1410	1460	1530	1620	1710	1770	1810	1850
5	720	860	1020	1150	1290	1390	1510	1660	1730	1830	1940	2050	2110	2180	2250
6	-	940	1100	1260	1420	1560	1700	1880	1970	2090	2220	2350	2430	2530	2640
7		-	1170	1360	1530	1690	1860	2030	2170	2310	2480	2630	2730	2860	2990
8			-	1440	1620	1800	1980	2170	2330	2500	2700	2870	2990	3150	3300
9				-	1700	1890	2080	2290	2470	2650	2890	3070	3230	3410	3570
10					-	1970	2170	2390	2590	2800	3040	3230	3430	3630	3800
11						-	2250	2490	2700	2920	3160	3380	3600	3820	-
12							-	2590	2800	3030	3270	3500	3750	-	

BOTTOM OF GATE OUT OF WATER															
ELEVATION OF POND WATER SURFACE (U.S.G.S.)															
1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060
550	750	975	1225	1475	1750	2050	2350	2675	3000	3350	3700	4075	4450	4850	5300

From Drawings #D-6492-9.1 and #D-6492-9.2 by E. Locke - January 19, 1956

A. L. Killam
mg:1-24-56

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

CANAAN HYDRO STATION

CANAAN, VERMONT

DAY OF WEEK _____ MONTH _____ DAY _____, 19__

READINGS TAKEN BY:						
TIME READINGS TAKEN:				GENERATOR OUTPUT			TIME HOUR ENDS
TRANSMISSION OCB #355 AMPS (2.4 KV)	ØX			PD DEMAND METER TAPE READ. x10	METER #150 K=100 READING	CALC.* MWH.	
	ØY						
	ØZ						
INDICATING KW.							1A
KWH METER #152 READING K=100							2
DISTRIB. OCB H-2 AMPS.	ØX						3
	ØY						4
	ØZ						5
GENERATOR A.C. AMPS	ØX						6A
	ØY						6 HR. TOT
	ØZ						7A
INDICATING KW							8
FIELD D.C. AMPS							9
FIELD D.C. VOLTS							10
A.C. VOLTAGE							11
FREQUENCY							12N.
KWH OUTPUT METER #150 K=100 READING							6 HR TOT.
KWH INPUT METER #151 K=10 READING							1P.
REACTIVE MVA (MX)							2
PD DEMAND COUNTER READING							3
BATTERY CHARGING D.C. VOLTS							4
WICKET GATE OPENING							5
HEADWATER ELEVATION U.S.G.S.							6P.
TAILWATER ELEVATION U.S.G.S.							6 HR TOT
NET HEAD							7P
WASTE GATE OPENING							8
DISCHARGE IN C.F.S.							9
WEATHER							10
TEMPERATURE INSIDE							11
TEMPERATURE OUTSIDE							12M
PRECIPITATION TO 8 A.M. =	MAX. TEMP. =		MIN. TEMP. =				6 HR TOT
							24 HR. TOT

FIREFLAKE 6 A.M.		
	ELEV.	
	DISCHARGE	
	PRECIP	

PITTSBURG 7 A.M.		
	ELEV.	
	DISCHARGE	
	PRECIP.	

OPERATION COUNTER 8 AM		
	OCB #355	
	OCB #H-2	
	OCB #G-1	
	12 KV. REG.	

TRANSFORMER TEMPERATURES 8 A.M.	WEST	MIDDLE	EAST
34.5-2.4 KV.			
34.5-12.47 KV.			

* To be entered by Dispatch. Dept

ST LTS OFF _____ A.M. ON _____ P.M.

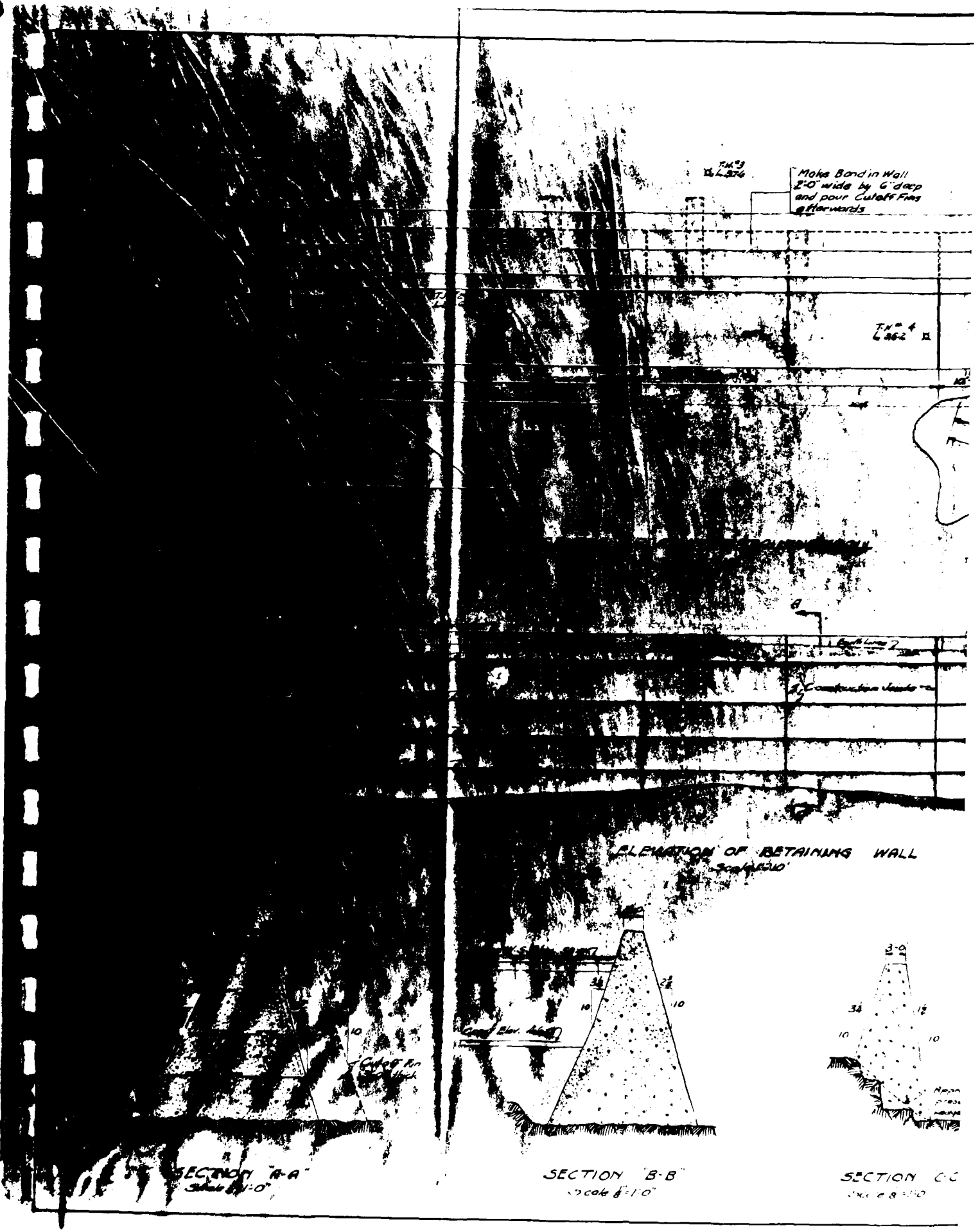
CONDITION OF FLASHBOARDS:

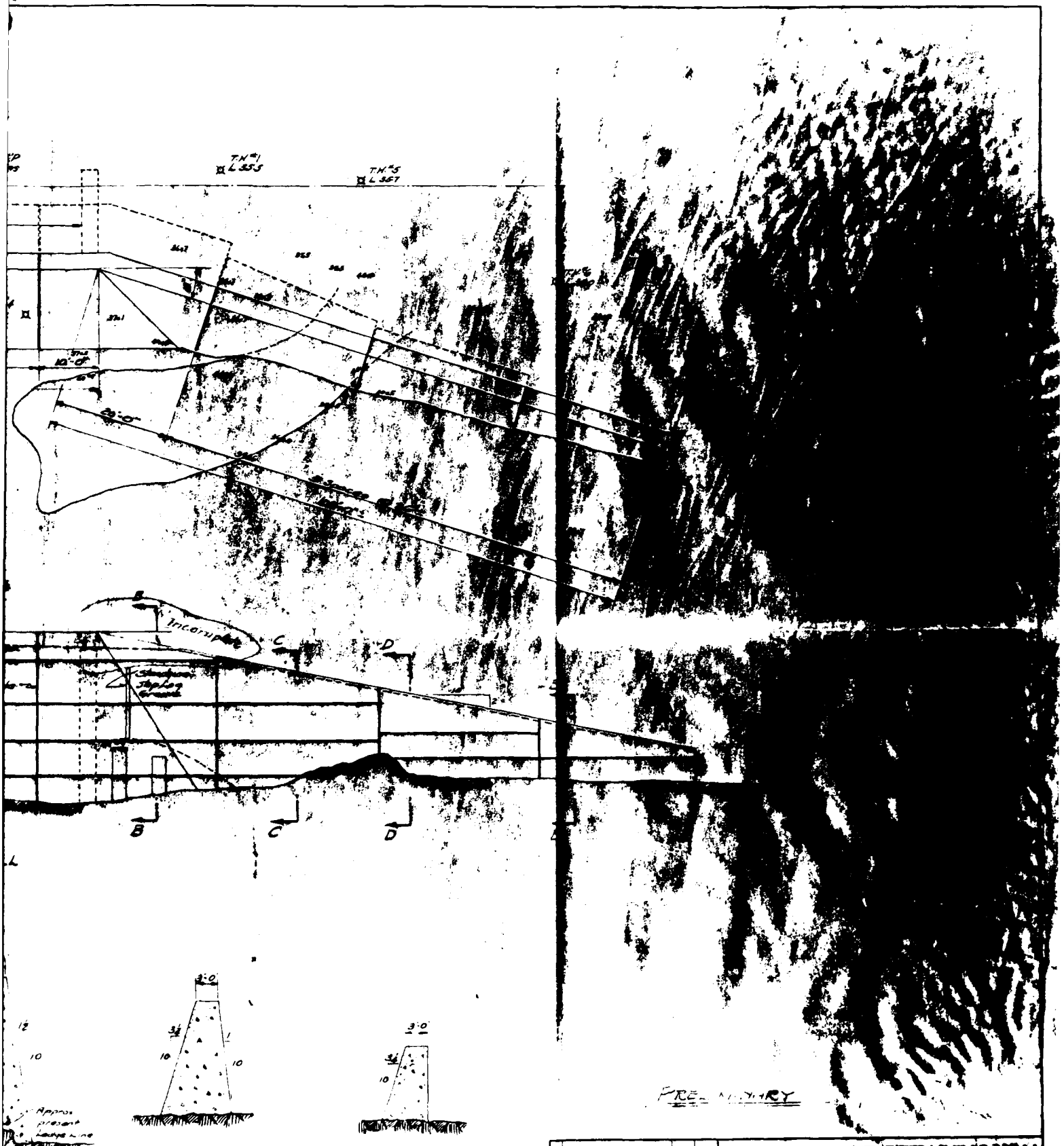
MONTHLY SUMMARY	GEN. OUTPUT #150 K=100		STA POWER #154 K=10	GATE POWER #157 K=10	GATE L.T.S. #156 K=1		TOTAL STA SERV. FOR MONTH
ESTIMATED READING MIDN'T LAST DAY THIS MONTH							
ESTIMATED READING MIDN'T LAST DAY LAST MONTH							NET GEN. FOR MONTH
KWH FOR MONTH	B-3						

Form #7167

GENERATOR DATA
1375 KVA. 1100 KW. ~3300V 345 A.C. AMPS. 8 P.F. 124 D.C. AMPS. 16 A.R.P.M.

PENSTOCK INV. 1040.0 — USGS ELEV.
TOP OF STAN. LOGS 1055.5 (100-YR) (2 EA. 8 FT)
HT STAN REM PANELS 4 FT
HT. FLASHBOARDS 3.5 FT
SILL 1037.0 — USGS ELEV.
SILL 1040.75
CREST 1051.5
CREST 1051.5
SILL 1046.0
WIDTH 10'
PENCILS
WASTE GATE 2.00'
MAIN DAM 139.5'
FULL GATE 10.04'
STANCHION


Make Bond in Wall 2'-0" wide by 6" deep and pour Cutoff Fins afterwards
Construction Joints
ELEVATION OF RETAINING WALL
SECTION "A-A"
SECTION "B-B"
SECTION C-C



SECTION "C-C"

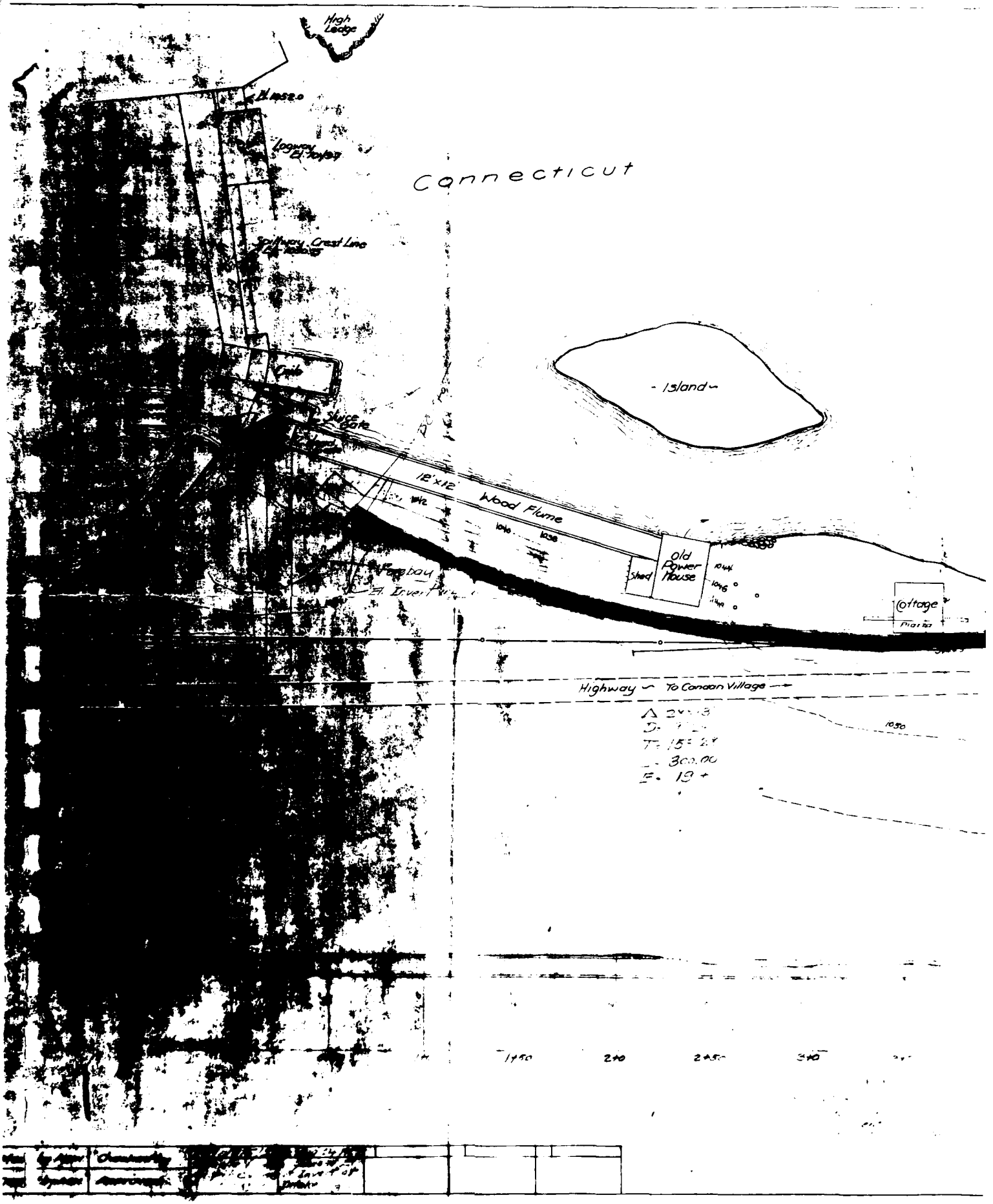
SECTION "D-D"
Scale 8'-1'-0"

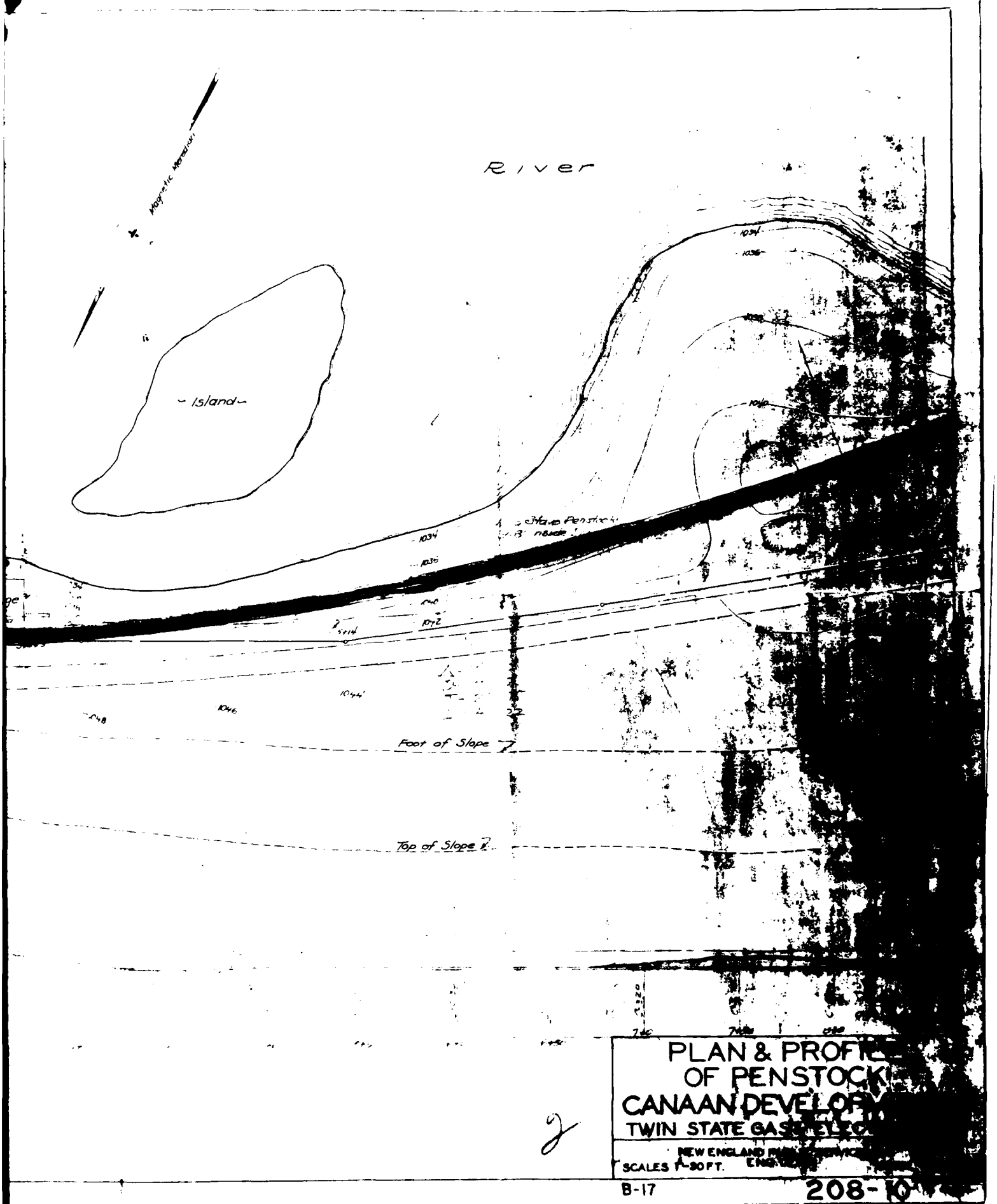
SECTION "E-E"
Scale 8'-1'-0"

PRELIMINARY

2 Changed Earthline 1 Issued		DETAILS EAST RETAINING WALL
MADE M.O.B.	CHKD	CANAAN DEVELOPMENT
TRACED M.E.Y.	APPR	PUBLIC SERVICE COMPANY OF N.H.
SCALE 1/8"=1'	DATE 8-19-69	NEPSCO SERVICES, INC. ENGINEERING DEPARTMENT — 208-155

2

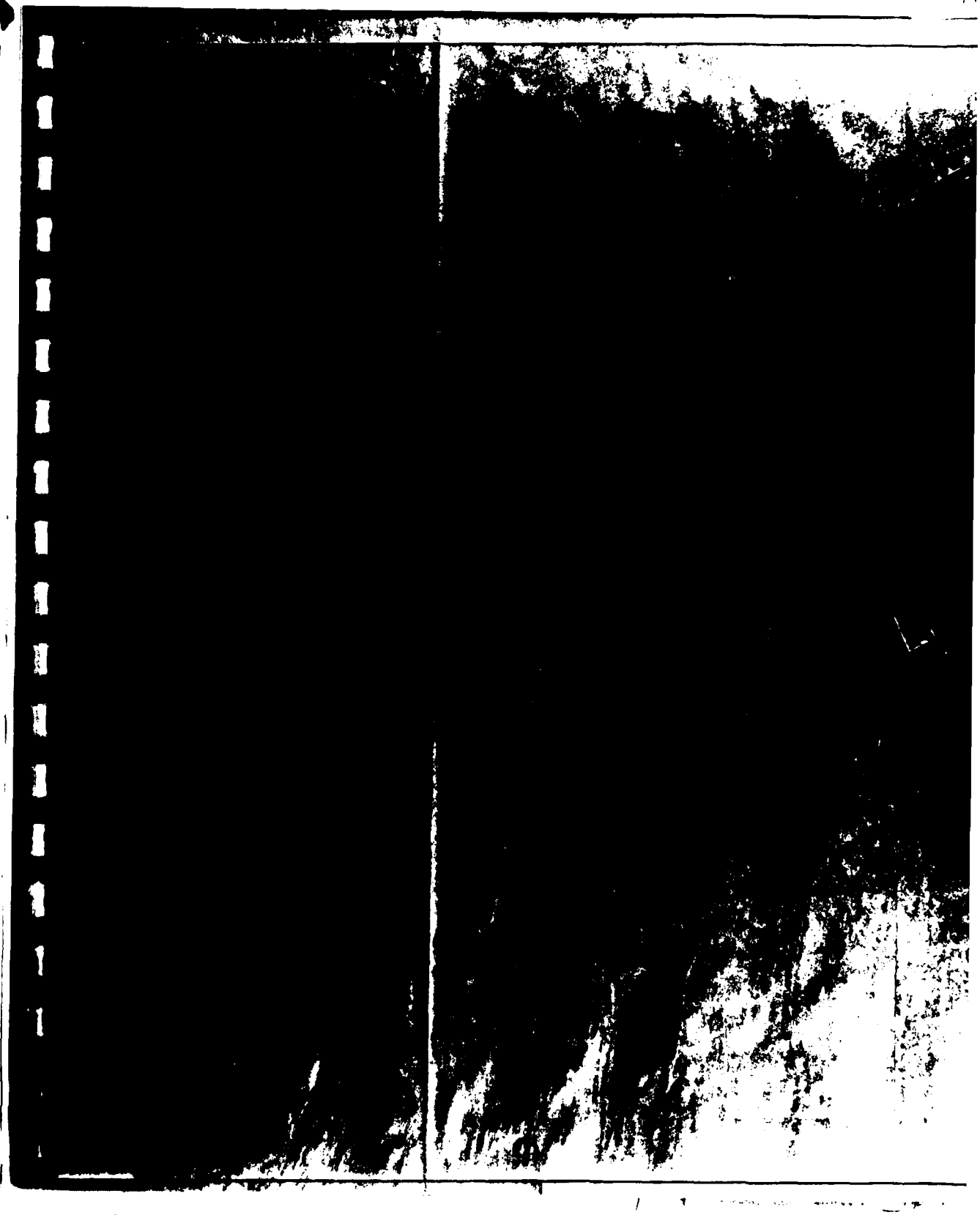

High Ledge
Connecticut
Spillway Crest Line
Island
Sluice Gate
12'x12' Wood Flume
Old Power House
Shed
Cottage
Highway — To Canaan Village —
1050
1044
1046
1038
1150
200
250
300

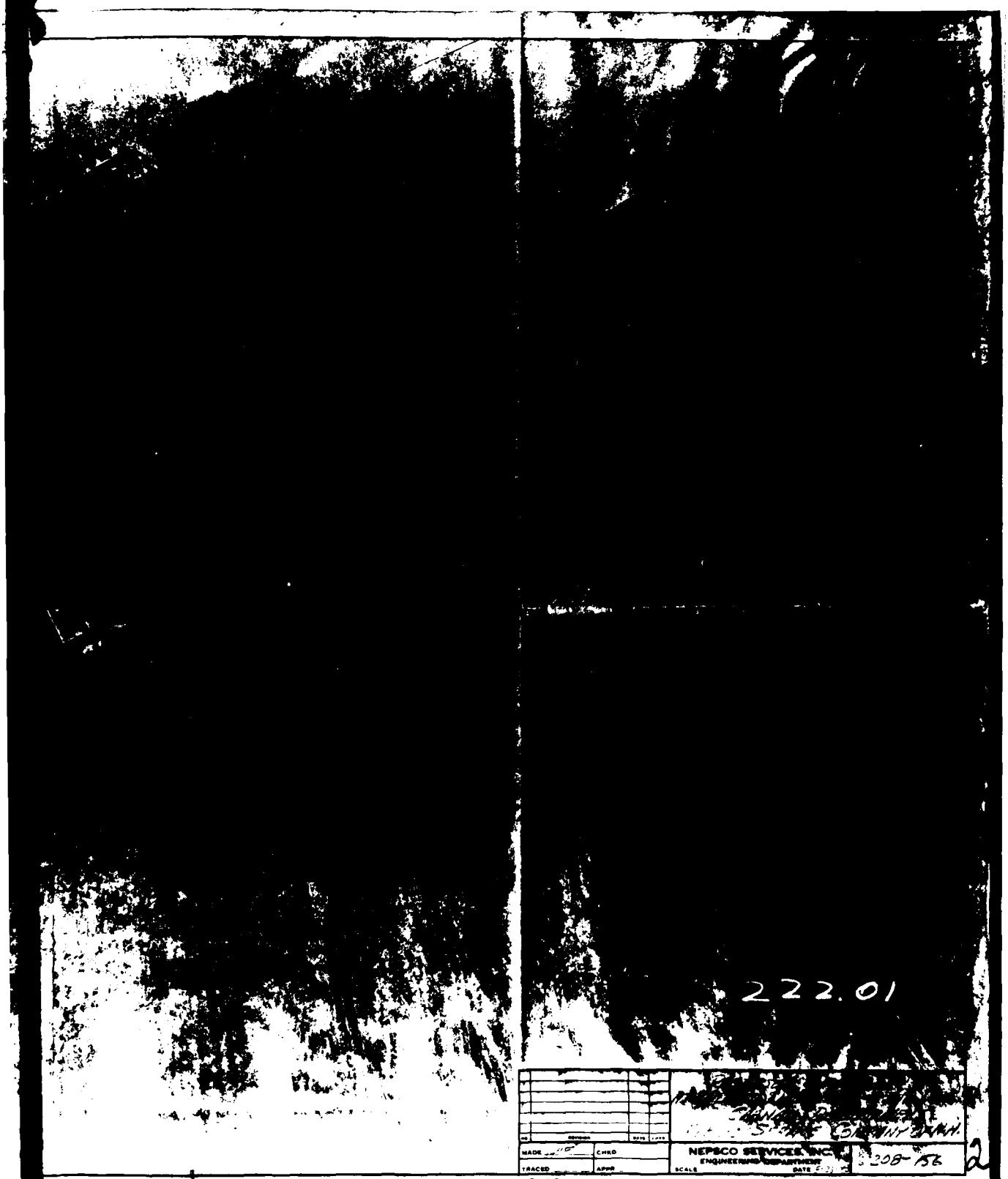


PLAN & PROFILE
OF PENSTOCK
CANAAN DEVELOPM
TWIN STATE GAS & ELEC
NEW ENGLAND
SCALES 1"=50 FT. ENG.

B-17

208-10




222.01
NEPSCO SERVICES, INC.
ENGINEERING DEPARTMENT
MADE
CHKD
TRACED
APPR
SCALE
DATE
208-56

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: Stewartstown Dam Number: [illegible]

Name of Dam, Stream and/or Water Body: Connecticut River

Owner: Public Service Co. Telephone Number: 603-4[illegible]

Mailing Address: Elm St. Manch. N.H.

Max. Height of Dam: 18'+ Pond Area: _____ Length of Dam: [illegible]

FOUNDATION: Ledge

OUTLET WORKS: 20½' Low Timber gate
12½' Low Head gate w/ Timber penstocks (stone)
12 stanchions (Skeleton log) 150' conc.
13' Concrete Crest w/ 4" Headboards

ABUTMENTS: Concrete in process of being repaired
- Note patching in photo - Appears to be
part of repair work in progress

EMBANKMENT:

Dam No._____

SPILLWAY: Length:_____ Freeboard:_____

SEEPAGE: Location, estimated quantity, etc.

[illegible] - [illegible]
[illegible] gate had slight leakage at time of inspection

Changes Since Construction or Last Inspection:

[illegible]

Tail Water Conditions:

[illegible]

Overall Condition of Dam: [illegible]

Contact With Owner: [illegible]

Date of Inspection: 6/12/79 Suggested Reinspection Date [illegible]

Class of Dam: [illegible]

Signature [illegible]

Date 6/13/79

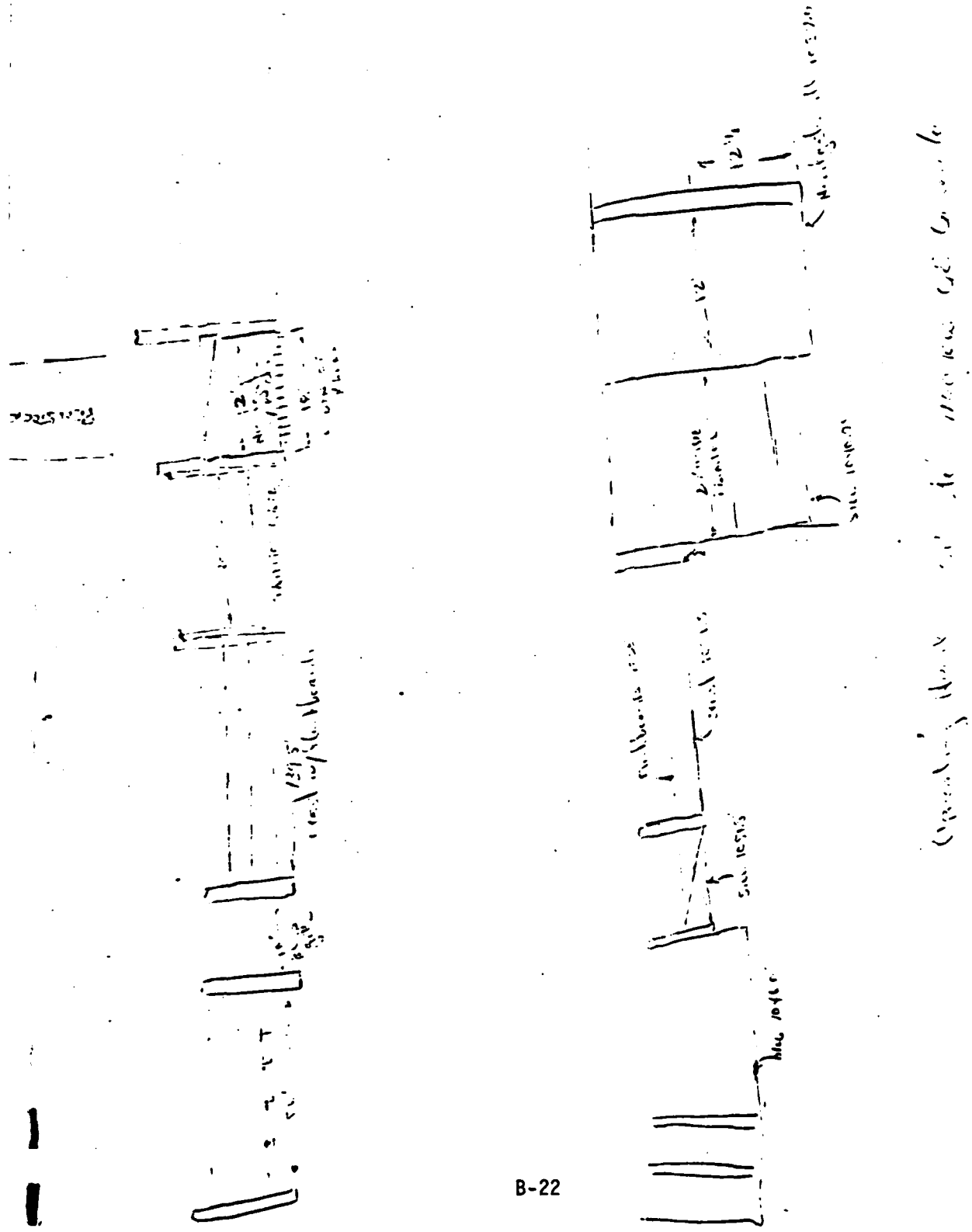
Dam No. [illegible]

COMMENTS:

Dam seems to be in fair condition except for [illegible] which has slowly [illegible]

Dam No._____

KETCH OF DAM (Show Plan, Elevation & Cross Sections)



N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: Stewartstown Dam Number: 222.01

Inspected by: SCB Date: 25 Sep 1975

Local name of dam or water body: _____

Owner: P.S. Co Address: Manchester

Owner ~~was~~/was not interviewed during inspection.

Drainage Area: _____ sq. mi. Stream: _____

Pond Area: _____ Acre, Storage _____ Ac-Ft. Max. Head _____ Ft.

Foundation: Type _____, Seepage present at toe - Yes/No, _____

Spillway: Type _____, Freeboard over perm. crest: _____,

Width _____, Flashboard height _____,

Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover _____ Width _____,

Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type _____, Condition: Good, Fair, Poor

Gates or Pond Drain: Size _____ Capacity _____ Type _____

Lifting apparatus _____ Operational condition _____

Changes since construction or last inspection: _____

Downstream development: _____

This dam would/would not be a menace if it failed.

Suggested reinspection date: _____

Remarks: Should be Reinspected with PSCo People

± 5 yr

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: _____ Dam Number: 222.01

Name of Dam, Stream and/or Water Body: _____

Owner: _____ Telephone Number: _____

Mailing Address: _____

Max. Height of Dam: _____ Pond Area: _____ Length of Dam: _____

FOUNDATION: Ledge

OUTLET WORKS: 20'6" tail[illegible]
12 sections of [illegible]
12½'± gate [illegible] (timber)
Pen stock

ABUTMENTS: Concrete [illegible]

EMBANKMENT: _____

Dam No._____

SPILLWAY: Length:_____ Freeboard:_____

SEEPAGE: Location, estimated quantity, etc.

None

Changes Since Construction or Last Inspection:

Tail Water Conditions:

Dry - Pasture

Overall Condition of Dam: Fair

Contact With Owner: Richard Owen - Spoke Kathy (20?)

Date of Inspection: 1-13-92 Suggested Reinspection Date 1992

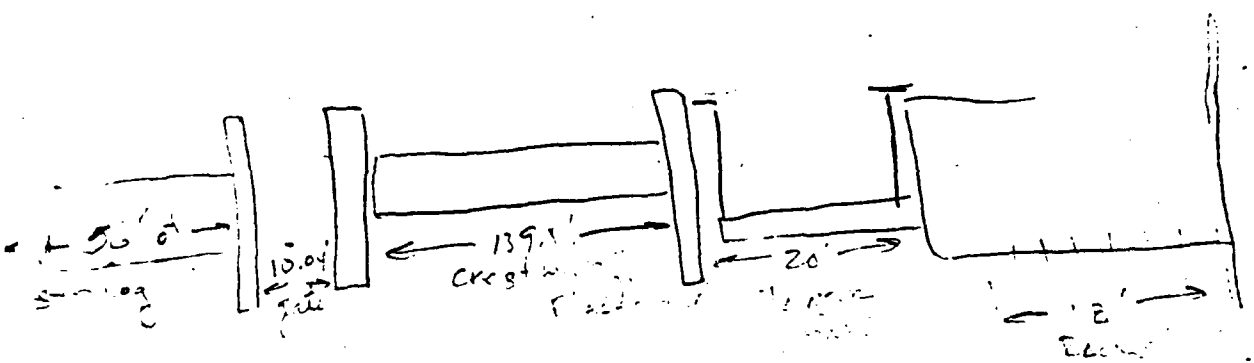
Class of Dam: Pond

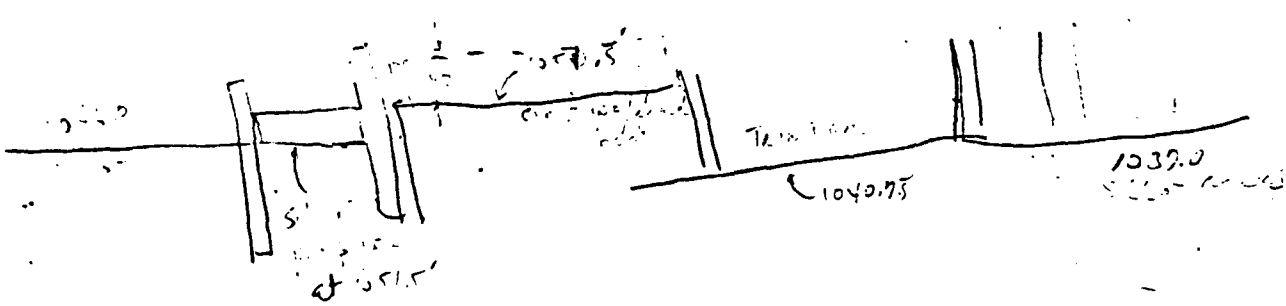
Signature _____

Date _____

Dam No. _____

SKETCH OF DAM (Show Plan, Elevation & Cross Sections)





LOWER DAM

TCG
7/9/80

Lower Dam is a complex structure, including two spillway sections with flashboards, a "stanchion section" with removable stop log panels and stoplogs, a waste gate, and a penstock. There are many configurations possible for the dam. The profile given on the next page is based on field notes and 1955 sketches of the dam. At the time of the inspection, the waste gate was out of the water, the flashboards were in place, and stop logs and removable panels in place.

Stage-Discharge Curve

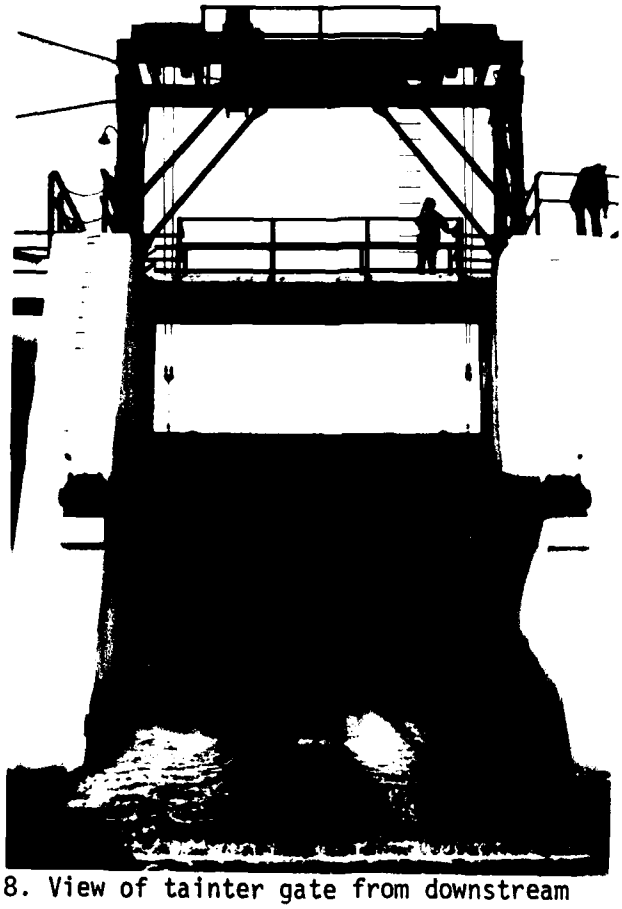
Stage-Discharge information for Lower Dam is included in Appendix B to this report. For the purposes of this stage-discharge curve, it will be assumed that the penstock is open, the waste gate is fully raised, the flashboards are gone, and the stop logs and removable panels (of the stanchion section) are in place. This corresponds to the likely operating procedure in the event of a major storm.

Penstock Flow

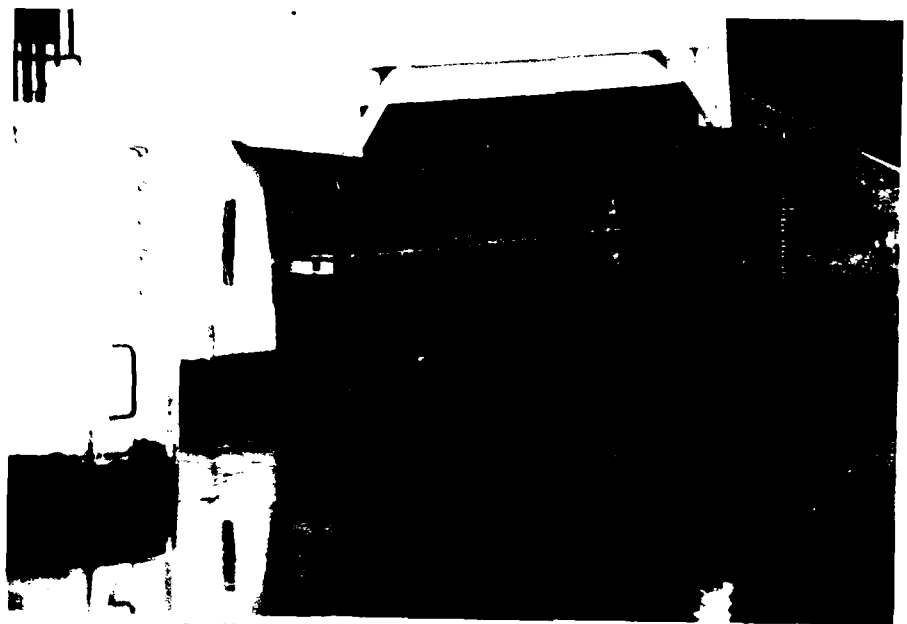
From the limited stage-discharge information available for the penstock, it would appear that the maximum outflow normally passed is about 550 cfs. It will be assumed that the penstock is under inlet control until the head is great enought to allow more than 550 cfs, at which point outlet control limits flow to this level.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

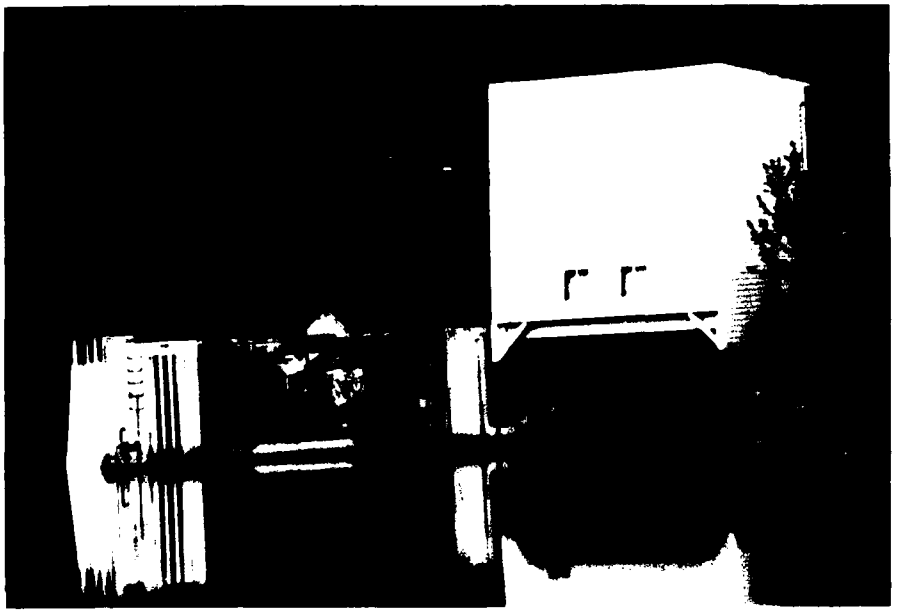


8. View of tainter gate from downstream

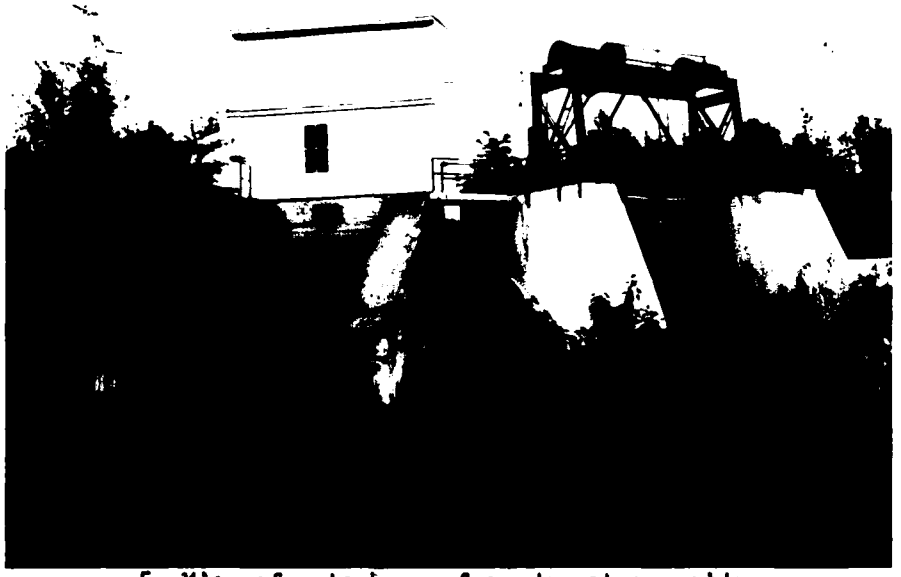


6. View of trash racks at head gate

7. View of head gate operating mechanism



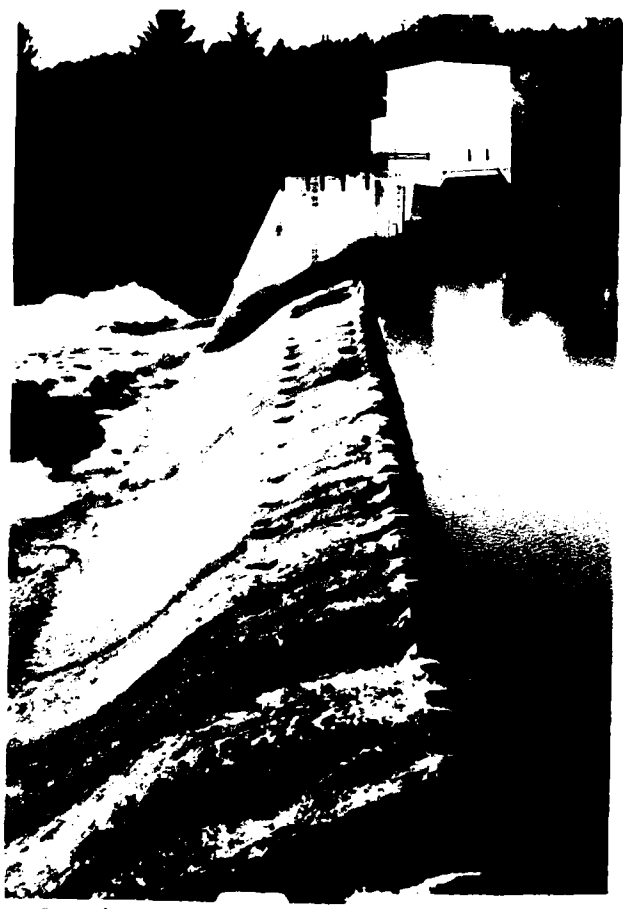
4. View of gate house from upstream side



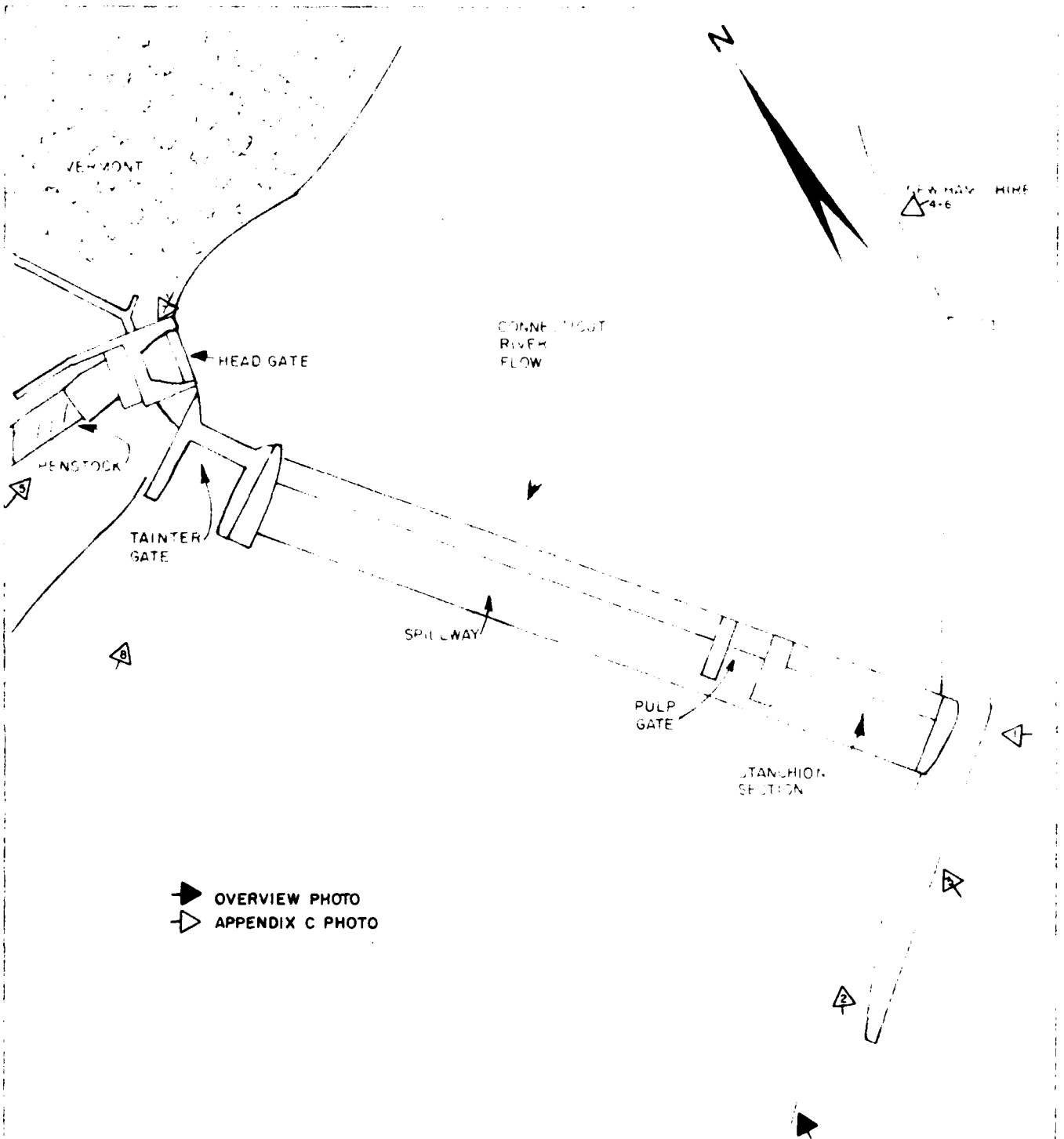
5. View of gate house from downstream side

2. View of stanchion section and pulp gate

3. Stoplogs in stanchion section
note metal strap on removeable stoplogs



1. View of spillway from left side



GOLDBERG ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCATION AND ORIENTATION OF PHOTOS

LOWER DAM — NEW HAMPSHIRE

SCALE SCHEMATIC

DATE JULY 1980

APPENDIX C

PHOTOGRAPHS

Co. .....

No. .....

CALCULATION SHEET

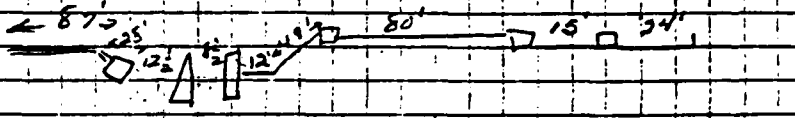
Date Aug 12

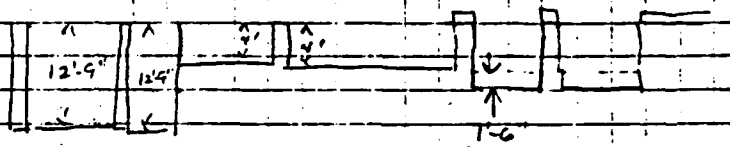
Refers to .....

Made By .....

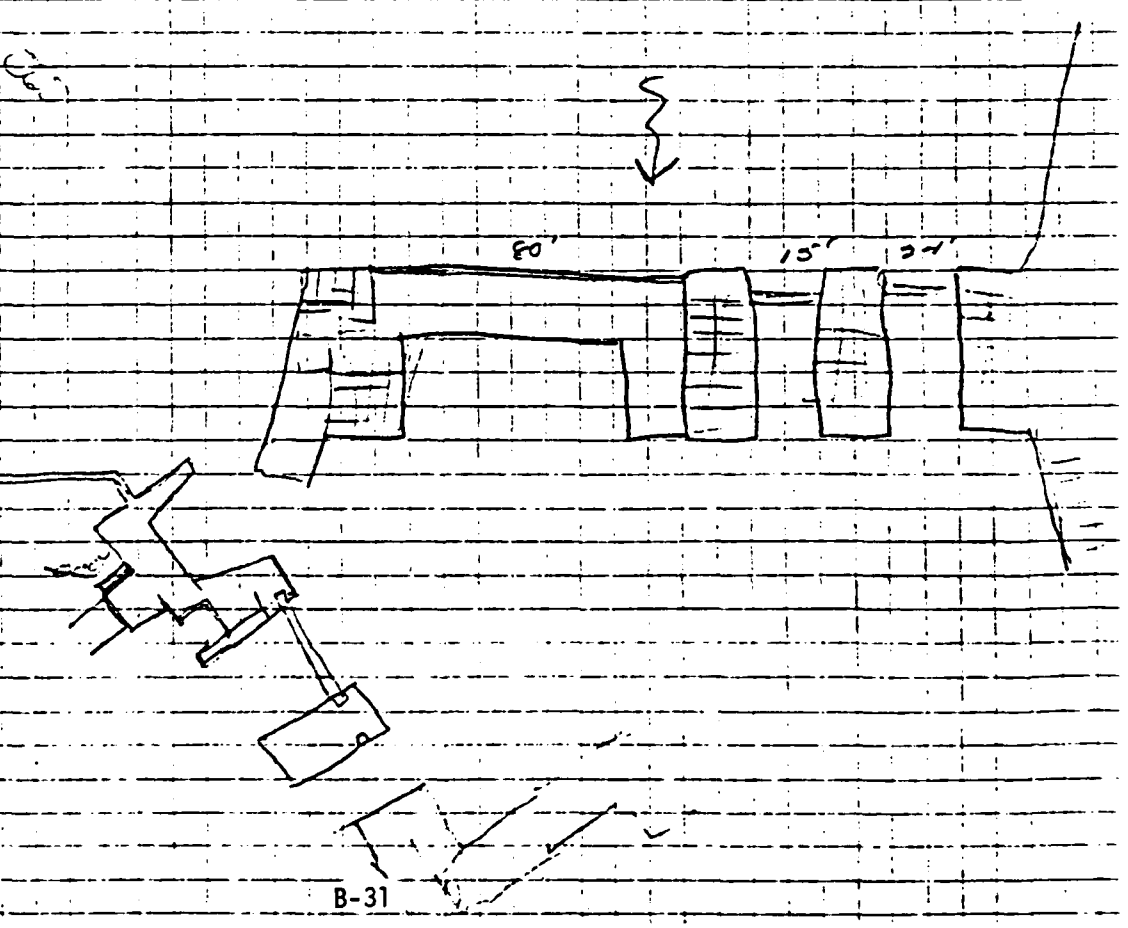
P.S. Co.

CANAAN – VT.





Height Above: 18'



NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM 222.01

BASIN Connecticut NO. 4- ~~-E-5434~~ (NRB 378)
RIVER Connecticut MILES FROM MOUTH 360.85 D.A.SQ.MI. 362.0
TOWN Stewartstown OWNER Public Service Co. of N.H. Manchester
LOCAL NAME OF DAM
BUILT _____ DESCRIPTION Crib — Logs, Timber, Concrete on Ledge

POND AREA-ACRES _____ DRAWDOWN FT. _____ POND CAPACITY-ACRE FT. _____
HEIGHT-TOP TO BED OF STREAM-FT. 18± MAX. _____ MIN. _____
OVERALL LENGTH OF DAM-FT. 345± MAX.FLOOD HEIGHT ABOVE CREST-FT. _____
PERMANENT CREST ELEV.U.S.G.S. _____ LOCAL GAGE _____
TAILWATER ELEV.U.S.G.S. _____ LOCAL GAGE _____
SPILLWAY LENGTHS-FT. 2 total/141 and 24 & 39 FREEBOARD-FT. 4.0 and 5.5
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST 4' Fixed cubic pull
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

1	12.5	12.75 Sluice
1	8.5	12.75 "

REMARKS Condition fair To be repaired

SB

POWER DEVELOPMENT

UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE
1	1550	31			S. Morgan Smith Vertical t.t.b.
1				1100	General Electric
	1550	35	Wheeler		

USE Power, Public Utility

REMARKS N.C. 2CC

DATE 5/1/26

Form E1A
4845

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5454

TOWN	STEWARTSTOWN	TOWN NO. 1	STATE NO. 222
RIVER STREAM	Connecticut River		
DRAINAGE AREA	(362 Sq. Mi.)	POND AREA	
DAM TYPE	Crib	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Logs, Timber, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	Approx. - 18'	TOP OF DAM TO SPILLWAY CRESTS	5'-6", 4'
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	61' 80' 15' 24' 1 - Gate 12⅔' wide x 12'-9" 4' 4' 6½' 6½' 1 - " 8⅓' " x 12'-9"		LENGTH OF DAM Approx. 34
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	Fixed - Cable Pull 4'		
OPERATING HEAD CREST TO N. T. W.	31'	TOP OF FLASHBOARDS TO N. T. W.	35'
WHEELS, NUMBER KINDS & H. P.	1- 1550 HP S Morgan Smith (Vertical Turbine)		
GENERATORS, NUMBER KINDS & K. W.	1- 1100 KW - GE		
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS			

REMARKS

OWNER: Public Service Co. of N.H.

CONDITION: Fair - to be repaired.

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made Aug. 12, 1936, according to notification to owner dated Aug. 5, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Aug. 13, 1936
Copy to Owner

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 222.01 ✓

Town Stewartstown ✓ : County Coos ✓

Stream Conn. R. ✓

Basin-Primary Ocean ✓ : Secondary Conn.R. ✓

Local Name Lower Dam ✓

Coordinates—Lat. : Long.

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 362.0 ✓ Sq. Mi.

Overall length of dam 345 ✓ ft.: Date of Construction

Height: Stream bed to highest elev. 18 ✓ ft.: Max. Structure 14 ✓ 12.5 ft.

Cost—Dam : Reservoir

DESCRIPTION Ledge Found. Logs, Timber, Concrete ✓

Waste Gates

Type (sluice gates)

Number 2 : Size 2, 12½-9" ft. high x 1, 12½ wide 1, 8½' wide ✓ ft. wide

Elevation Invert : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type stone&earth ✓

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction logs, timber, concrete

Length—Total 61, 80, 15, 24, ft.: Net 180 ✓ ft.

Height of permanent section—Max. 14' ft.: Min. 12.5 ft.

Flashboards—Type Fixed cable pull : Height ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 5.5 ✓ ft.: Min. 4.0 ✓ ft.

Headworks to Power Devel.—(See "Data on Power Development") /

OWNER Public Service Co., of N.H. Manchester, NH

REMARKS Condition fair, to be repaired
This Dam is Menace
Use Power, Public Utility

Tabulation By RLT Date 6/23/39

B&B21284

7206

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. .....

Town Stewartstown : County Coos

Stream Conn.R.

Basin-Primary Ocean : Secondary Conn.R.

Local Name Lower Dam

GENERAL DATA

Head-Max. ..... ft.: Min. ..... ft.: Ave. 35 ft.

Date of Construction .....: Use of Power Power,Public Utility

Pondage ..... ac. ft.: Storage ..... ac. ft.

DESCRIPTION

Racks

Size of Rack Opening .....

Size of Bar .....: Material .....

Area: Gross ..... Sq. Ft.: Net ..... sq. ft.

Head Gates

Type .....

Number .....: Size ..... ft. high x ..... ft. wide

Elevation of Invert .....: Total Area ..... sq. ft.

Hoist .....

Penstock

Number 1 : Material wooden

Size .....: Length .....

Turbines

Number 1 : Makers S.Morgan Smith(Vertical Turbine)

Rating HP. per unit 1550 : Total Capacity 1550 HP.

Max. Dement C.F.S., per unit .....: Total ..... cfs.

Drive

Type .....

Generator

Number 1

Make General Electric

Rating KW., per unit 1100 ; Total Capacity 1100 K. W.

Exciter

Number .....: Make .....

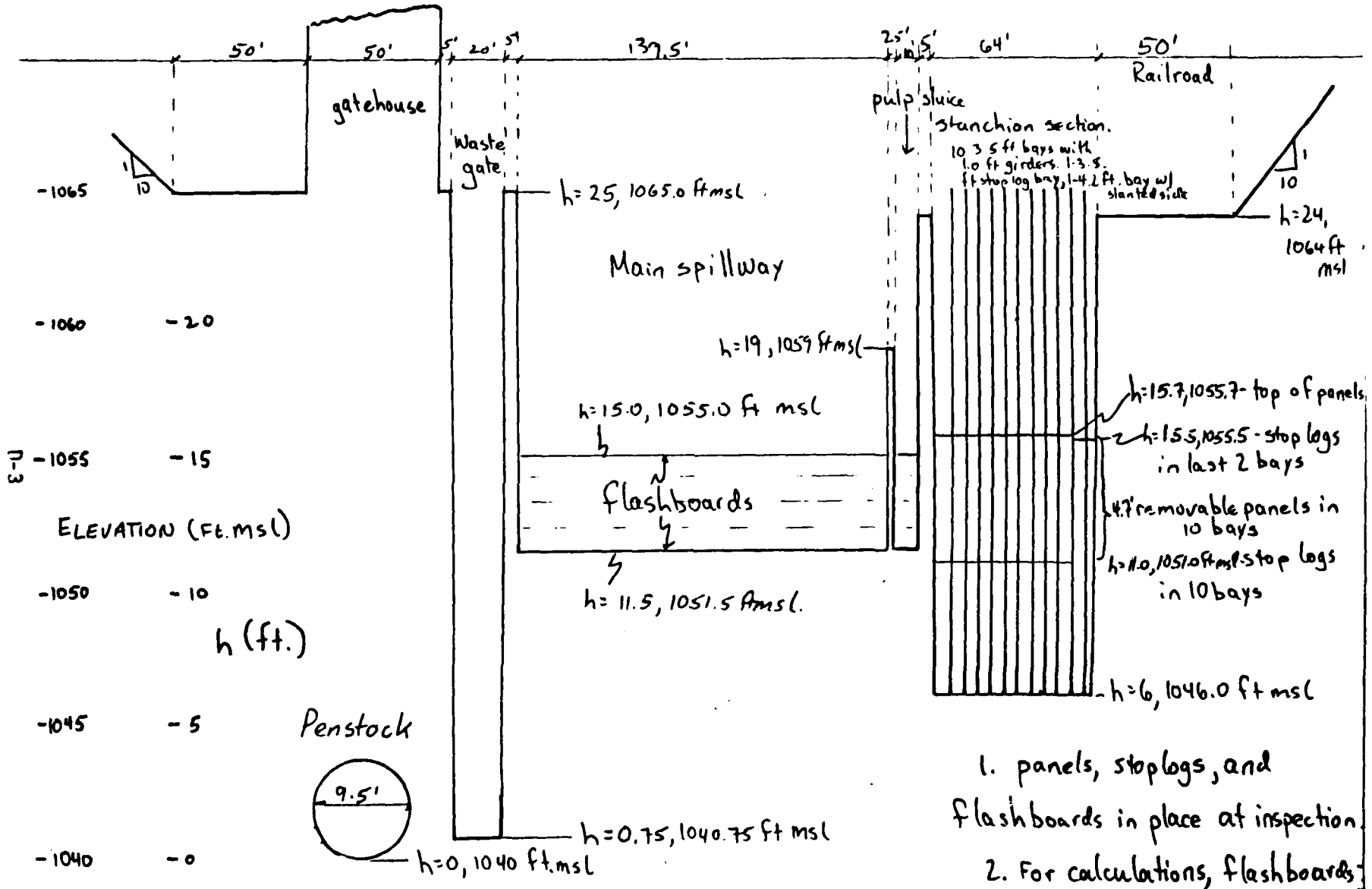
Rating-per unit .....: Total Capacity ..... K. W.

OUTPUT—KWHRS

19.....	.....:	19.....	.....
19.....	.....:	19.....	.....
19.....	.....:	19.....	.....
19.....	.....:	19.....	.....
19.....	.....:	19.....	.....

OWNER Public Service Co. of NH Manchester,NH

Tabulation By RLT Date 8/30/39



1. panels, stoplogs, and flashboards in place at inspection.
2. For calculations, flashboards assumed gone, penstock open, Waste gate open.

LOWER DAM

TCG 7/9/80

D-3

This is admittedly a crude estimate of penstock flows, but these flows represent only a small percentage of total project outflow.

The penstock flow under inlet control can be estimated using the Federal Highway Administration's Hydraulic Engineering Circular #5, which allows the calculation of flows given a certain head. The chart below gives stage-discharge information for the penstock:

Penstock Flow

Stage (h) (ft)	Elevation (ft msl)	1. h/d	$Q^{2.}$ (cfs)
0	1040	0	$0_{3.}$
1	1041	.11	$10^{3.}$
2	1042	.21	$50^{3.}$
3	1043	.32	$100^{3.}$
4	1044	.42	$160^{3.}$
5	1045	.53	235
6	1046	.63	310
7	1047	.74	405
8	1048	.84	510
9+	1049+	-	550

Notes:

1. D=penstock diameter = 9.5 ft.
2. from Chart 2, HEC-5-maximum of 550 cfs.
3. h/d too low for chart-estimated.

Waste Gate Flow

The waste gate for the dam is a Tainter gate, and is assumed to be lifted out of the water. The flow for water surfaces between 1045 and 1060 ft. msl is given in Appendix B. For other water surface elevations, $Q = 3.14\ (20)\ (h_{gate})^{3/2}$ is used, where $h_{gate} = h-0.75$ ft.

LOWER DAM

TCG
7/9/80

Waste Gate Flow

h (ft)	Elevation (ft msl)	Stage over-gate sill (h gate, ft)	Q[1]
.75	1040.75	0	0
1	1041	.25	8
2	1042	1.25	88
3	1043	2.25	210
4	1044	3.25	370
5	1045	4.25	550
6	1046	5.25	750
7	1047	6.25	975
8	1048	7.25	1225
9	1049	8.25	1475
10	1050	9.25	1750
11	1051	10.25	2050
12	1052	11.25	2350
13	1053	12.25	2675
14	1054	13.25	3000
15	1055	14.25	3350
16	1056	15.25	3700
17	1057	16.25	4075
18	1058	17.25	4450
19	1059	18.25	4850
20	1060	19.25	5300
21	1061	20.25	5720
22	1062	21.25	6150
23	1063	22.25	6590
24	1064	23.25	7040
25	1065	24.25	7500
26	1066	25.25	7970
27	1067	26.25	8450
28	1068	27.25	8930
29	1069	28.25	9430
30	1070	29.25	9930
31	1071	30.25	10400
32	1072	31.25	11000
33	1073	32.25	11500
34	1074	33.25	12000
35	1075	34.25	12600

Notes:

1. from "Canaan Hydro Station - Discharge of Waste Gate in cfs" table given in Appendix B for 1045-1060 ft. msl.

   Otherwise $Q = 3.14\ (20)\ (h_{gate})^{3/2}$

LOWER DAM

TCG
7/10/80

Spillway and "Pulp Sluice" Flow

The spillway and pulp sluice gate flow will be calculated with the flashboards out. If they were in place at the beginning of a large storm, they would fail under the pressure of high flows. The flow for water surfaces from 1051.5 (spillway crest) to 1060 ft. msl is given in "Canaan Hydro Station-Discharge Over Dam (No Flashboards On)" in Appendix B. For elevations above 1060 ft. msl, $Q = 3.33 LH_{sw}^{3/2}$ was used, where $H_{sw} = h-11.5$; $L = 149.5$. This relationship is given on the Table in Appendix B.

Spillway and "Pulp Sluice" Flow

Stage (h) (ft)	Elevation (ft msl)	H_{SW} (h-11.5) (ft)	Q (cfs)
11.5	1051.5	0	0
12	1052	.5	180
13	1053	1.5	910
14	1054	2.5	1970
15	1055	3.5	3260
16	1056	4.5	4750
17	1057	5.5	6420
18	1058	6.5	8250
19	1059	7.5	10,200
20	1060	8.5	12,300
21	1061	9.5	14,600
22	1062	10.5	16,900
23	1063	11.5	19,400
24	1064	12.5	22,000
25	1065	13.5	24,700
26	1066	14.5	27,500
27	1067	15.5	30,400
28	1068	16.5	33,400
29	1069	17.5	36,400
30	1070	18.5	39,600
31	1071	19.5	42,900
32	1072	20.5	46,200
33	1073	21.5	49,600
34	1074	22.5	53,100
35	1075	23.5	56,700

Stanchion Section Flow

Stanchion section flow will be calculated with all stop logs and panels in place. The flow from 1055.5 to 1058 ft. msl is given in Appendix B on "Canaan Hydro Station - Discharge over Boards, All Boards in Place". Flow for elevations above 1058 will be calculated using $Q = 3.33\ L_1 H_{SECT1}^{3/2}$ plus $3.33\ L_2 H_{SECT2}^{3/2}$, where L_1 = 35 ft., H_{SECT1} = h-15.7 ft., L_2 = 7.7 ft., H_{SECT2} = h-15.5 ft.

Flow Over Stanchion Section

Stage (h) (ft)	Elevation (ft msl)	Q (cfs)
15.5	1055.5	0
16	1056	28
17	1057	220
18	1058	510
19	1059	870
20	1060	1280
21	1061	1750
22	1062	2270
23	1063	2830
24	1064	3420
25	1065	4060
26	1066	4730
27	1067	5430
28	1068	6160
29	1069	6920
30	1070	7710
31	1071	8540
32	1072	9390
33	1073	10,300
34	1074	11,200
35	1075	12,100

LOWER DAM

TCG
7/10/80

Top of Dam Flow

From the dam profile, the top of the dam includes 2.5 ft. at 1059 ft. msl (h = 19); 55 ft. at 1064 ft. msl (h = 24); 60 ft. at 1065 ft. msl (h = 25); and 2 10:1 side slopes, beginning at 1064 ft. msl and 1065 ft. msl. Thus:

$$Q = 2.8\ (2.5)\ (h-19)^{3/2} + 2.8\ (55)\ (h-24)^{3/2} + 2.8\ (60)\ (h-25)^{3/2}$$
$$+ 2.8\ (10)\ (h-24)\ \ (0.5(h-24))^{3/2} + 2.8\ (10)\ (h-25)\ (0.5(h-25))^{3/2}$$

C = 2.8 for broad-crested earth weirs and concrete weirs with obstructions.

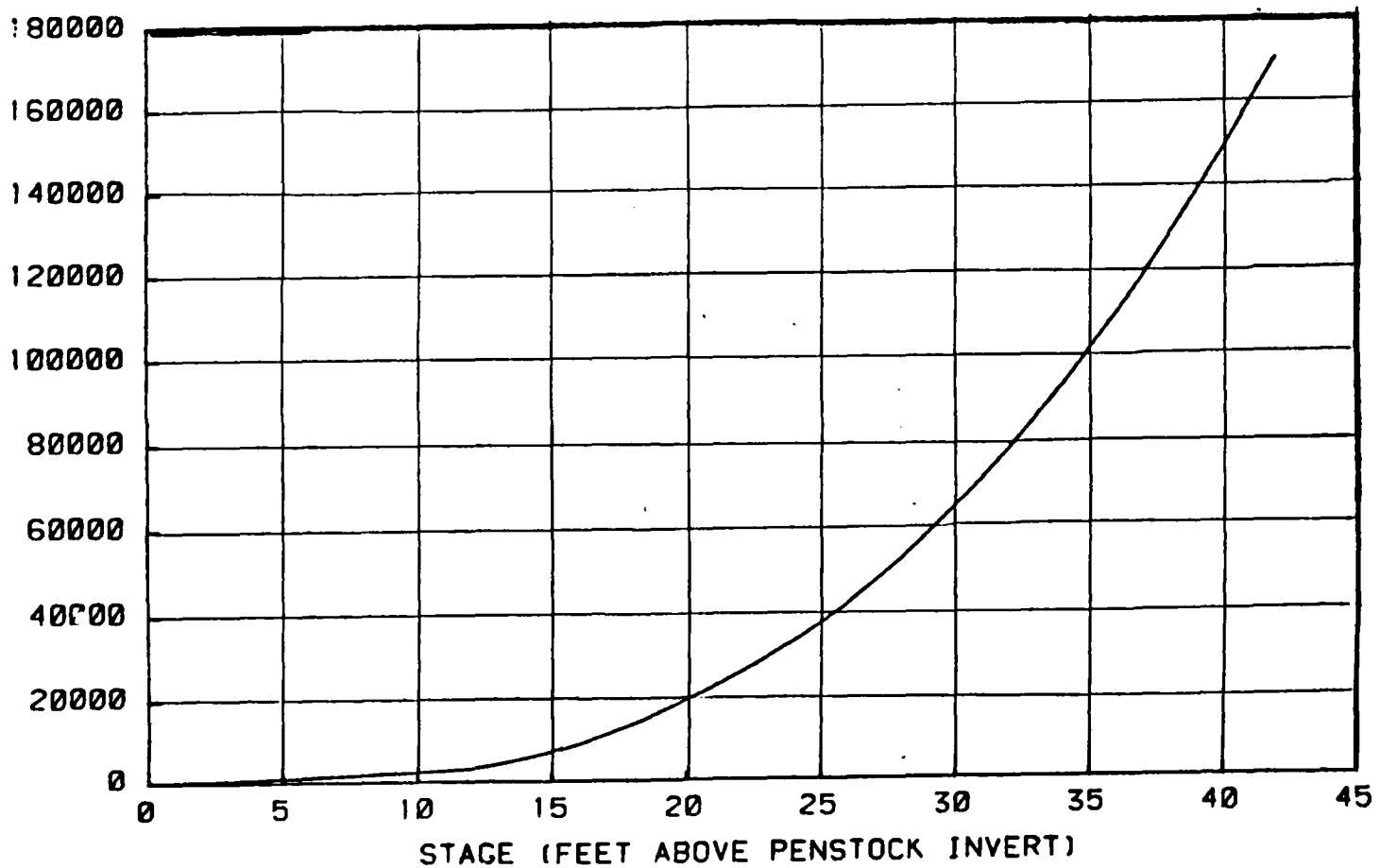
Flow Over Dam Crest

Stage (h) (ft)	Elevation (ft msl)	Q (cfs)
19	1059	0
20	1060	7
21	1061	20
22	1062	36
23	1063	56
24	1064	78
25	1065	270
26	1066	800
27	1067	1640
28	1068	2770
29	1069	4160
30	1070	5820
31	1071	7770
32	1072	10,000
33	1073	12,500
34	1074	15,300
35	1075	18,500

Total Project Discharge

Stage (h) (ft)	Elevation (ft msl)	Penstock Flow (cfs)	Waste Gate Flow (cfs)	Spillway and 'Pulp Sluice' Flow (cfs)	Stanchion Section Flow (cfs)	Top of Dam Flow (cfs)	Total Flow (cfs)
0	1040	0	0	0	0	0	0
1	1041	10	8	0	0	0	18
2	1042	50	88	0	0	0	140
3	1043	100	210	0	0	0	310
4	1044	160	370	0	0	0	530
5	1045	235	550	0	0	0	885
6	1046	310	750	0	0	0	1060
7	1047	405	975	0	0	0	1380
8	1048	510	1225	0	0	0	1740
9	1049	550	1475	0	0	0	2030
10	1050	550	1750	0	0	0	2300
11	1051	550	2050	0	0	0	2600
12	1052	550	2350	180	0	0	3080
13	1053	550	2675	910	0	0	4140
14	1054	550	3000	1970	0	0	5520
15	1055	550	3350	3260	0	0	7160
16	1056	550	3700	4750	28	0	9030
17	1057	550	4075	6420	220	0	11,300
18	1058	550	4450	8250	510	0	13,800
19	1059	550	4850	10,200	870	0	16,500
20	1060	550	5300	12,300	1280	7	19,400
21	1061	550	5720	14,600	1750	20	22,600
22	1062	550	6150	16,900	2270	36	25,900
23	1063	550	6590	19,400	2830	56	29,400
24	1064	550	7040	22,000	3420	78	33,100
25	1065	550	7500	24,700	4060	270	37,100
26	1066	550	7970	27,500	4730	800	41,600
27	1067	550	8450	30,400	5430	1640	46,500
28	1068	550	8930	33,400	6160	2770	51,800
29	1069	550	9430	36,400	6920	4160	57,500
30	1070	550	9930	39,600	7710	5820	63,600
31	1071	550	10,400	42,900	8540	7770	70,200
32	1072	550	11,000	46,200	9390	10,000	77,100
33	1073	550	11,500	49,600	10,300	12,500	84,500
34	1074	550	12,000	53,100	11,200	15,300	92,200
35	1075	550	12,600	56,700	12,100	18,500	100,500

STAGE-DISCHARGE CURVE FOR LOWER DAM



LOWER DAM

TCG
7/10/80

Stage-Storage Relationship

The normal storage behind Lower Dam (with the water at the spillway crest, 1051.5 ft. msl, h=11.5) is 90 acre-feet. The surface area of the pond behind the dam is about 15 acres. Assuming no spreading as the pond rises:

surcharge storage = 15 (h-11.5)

Total storage = 90 + 15 (h-11.5)

For the drainage area of 362 square miles:

$$1\text{" of runoff} = \frac{362\ (640)\ (1")}{12\ ("/ft)} = 19{,}307 \text{ ac-ft}$$

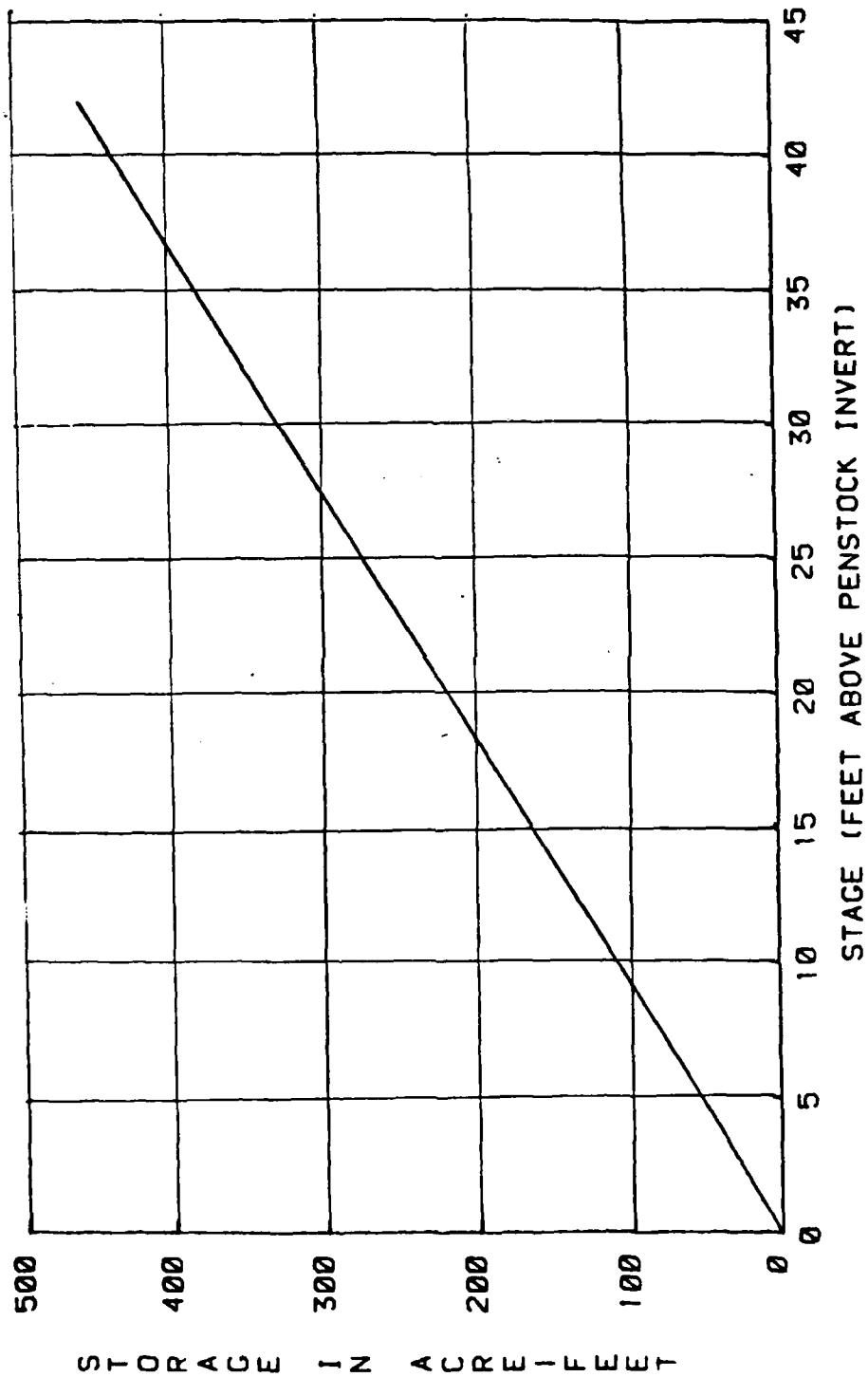
$$1 \text{ ac ft} = \frac{1}{19{,}307} = 0.000052 \text{ inches of runoff}$$

Surcharge storage to right abutment of dam (h = 24)

= 15 (2.4-11.5) = 187.5 ac-ft = .0098 inches of runoff

At the dam crest, total storage = 90 + 187.5 = 277.5 ac-ft. The stage-storage curve is given on the next page.

STAGE-STORAGE CURVE FOR LOWER DAM



LOWER DAM

TCG
7/10/80

Dam Failure Analysis

Assume failure occurs when water overtops the right abutment, h = 24, 1064 ft. msl.

PEAK FAILURE OUTFLOW = NORMAL OUTFLOW + BREACH OUTFLOW

Normal outflow = 33,100 cfs

Breach outflow = $Q_{pl} = 8/27 \sqrt{g} \; W_b \; Y_0^{3/2}$

$W_b \leq .4$ (width at ½ height) = .4 (251) = 100 ft.

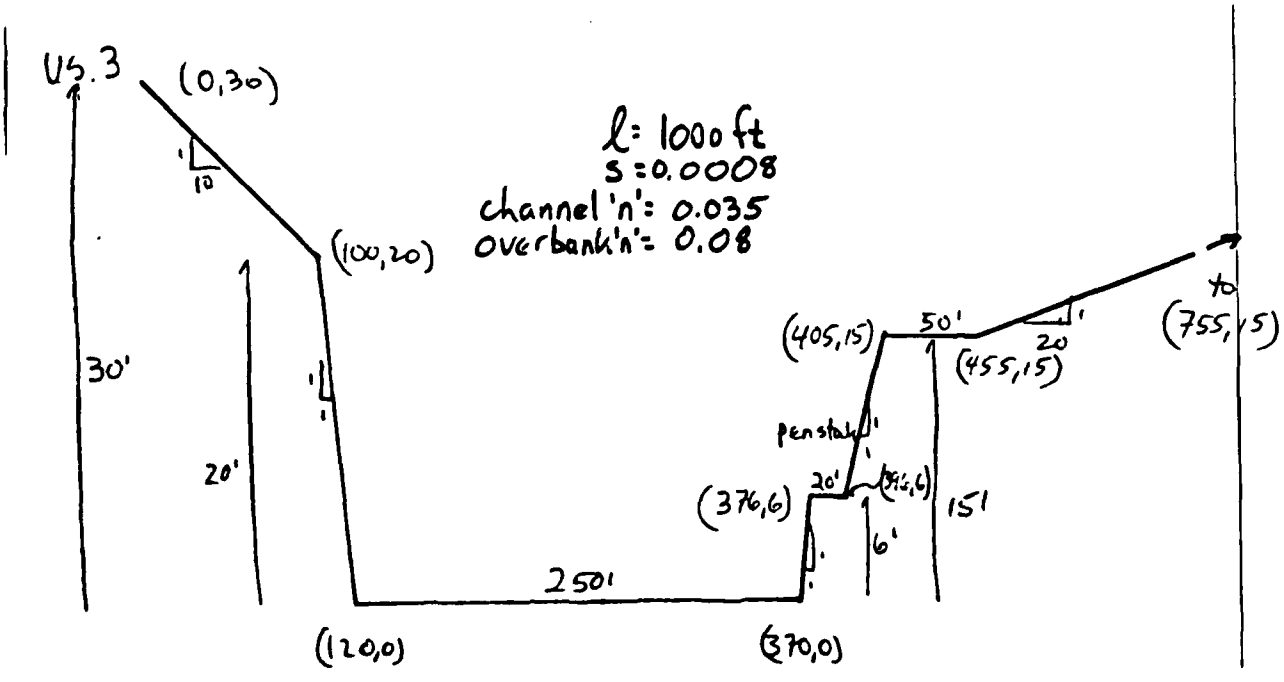
Y_0 = water surface height above channel invert at failure

= 1064 - 1037 = 27 ft.

so, $Q_{pl} = 8/27 \sqrt{g} \; (100) \; (27)^{3/2} = 23{,}600$ cfs

Peak failure flow = 33,100 + 23,600 = 56,700 cfs

The first 1000 feet downstream of Lower Dam have a very wide channel, for which the following section is typical (from field notes and USGS topo information):



LOWER DAM

RESOURCE ANALYSIS
a Camp Dresser & McKee firm

TCG
7/10/80

The stage-normal flow relationship for this reach is given on the next page. The prefailure flow of 33,100 cfs would cause a stage of 16.6 ft. in the stream below the dam. At the upstream end of this reach, the peak failure flow of 56,700 cfs would create a stage of 22.4 feet, an increase of 5.8 ft.

The total storage behind the dam above the tailwater level would be $\frac{15 \text{ ac ft}}{\text{ft}}$ (1064 ft - 1037 ft - 16.6 ft) = 156 ac-ft. The failure flow would begin to attenuate in the channel of the Connecticut downstream of the dam. The attenuation in the first 1000 ft. downstream of the dam is calculated on page D-16, assuming a linear variation in flow area along the reach. (Thus, reach storage = length x average area. Average area = $\frac{\text{area upstream} + \text{area downstream}}{2}$. The area of the failure wave at the upstream end is 2605 ft.^{2}).

The attenuated dam failure flow at the downstream end of the reach is 49,100 cfs, with a stage of 20.7 feet. Development in this 1000-foot reach includes the penstock with its invert about 6 ft. above the stream, a power generating station about 12 ft. above the stream, a house 14.5 ft. up and two more houses 16 feet up. Vermont 102 is about 16 feet above the channel for most of the reach. The development most subject to flooding is on the Canaan, Vermont side of the river. There are also many houses on both sides of the river greater than 20 feet above the channel - most are more than 25 feet up.

The penstock and power station would probably be severely damaged by pre-failure flow, and the dam failure flow would increase the stage sufficiently to probably ensure their destruction. Flooding at the low-lying house, about ½ way down the reach, would increase from 2.1 feet to

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.00	1.0	251.0	252.8	1.0	249.8	300.8
2.00	2.0	504.0	255.7	2.0	792.4	954.2
3.00	3.0	759.0	258.5	2.9	1556.4	1874.1
4.00	4.0	1016.0	261.3	3.9	2512.2	3025.0
5.00	5.0	1275.0	264.1	4.8	3641.6	4385.1
6.00	6.0	1536.0	267.0	5.8	4931.9	5938.8
7.00	7.0	1819.0	289.8	6.3	6189.6	7708.3
8.00	8.0	2104.0	292.6	7.2	7837.9	9667.4
9.00	9.0	2391.0	295.5	8.1	9637.7	11805.0
10.00	10.0	2680.0	298.3	9.0	11582.6	14113.4
11.00	11.0	2971.0	301.1	9.9	13667.5	16586.2
12.00	12.0	3264.0	303.9	10.7	15887.7	19218.0
13.00	13.0	3559.0	306.8	11.6	18239.3	22004.2
14.00	14.0	3856.0	309.6	12.5	20718.9	24940.7
15.00	15.0	4155.0	312.4	13.3	23323.3	28023.8
16.00	16.0	4515.5	383.9	11.8	23355.8	31093.8
17.00	17.0	4897.0	405.3	12.1	25784.9	34531.1
18.00	18.0	5299.5	426.7	12.4	28419.5	38147.4
19.00	19.0	5723.0	448.2	12.8	31266.0	41945.5
20.00	20.0	6167.5	469.6	13.1	34331.0	45928.0
21.00	21.0	6637.5	499.7	13.3	37228.3	50251.3
22.00	22.0	7137.5	529.8	13.5	40413.0	54781.6
23.00	23.0	7667.5	559.8	13.7	43891.5	59525.9
24.00	24.0	8227.5	589.9	13.9	47671.0	64490.0
25.00	25.0	8817.5	620.0	14.2	51759.1	69679.8
26.00	26.0	9437.5	650.1	14.5	56164.0	75100.5
27.00	27.0	10087.5	680.1	14.8	60894.1	80757.3
28.00	28.0	10767.5	710.2	15.2	65957.8	86655.2

Stage Vs. Normal Flow for First 1000 Ft. D/s of DAM

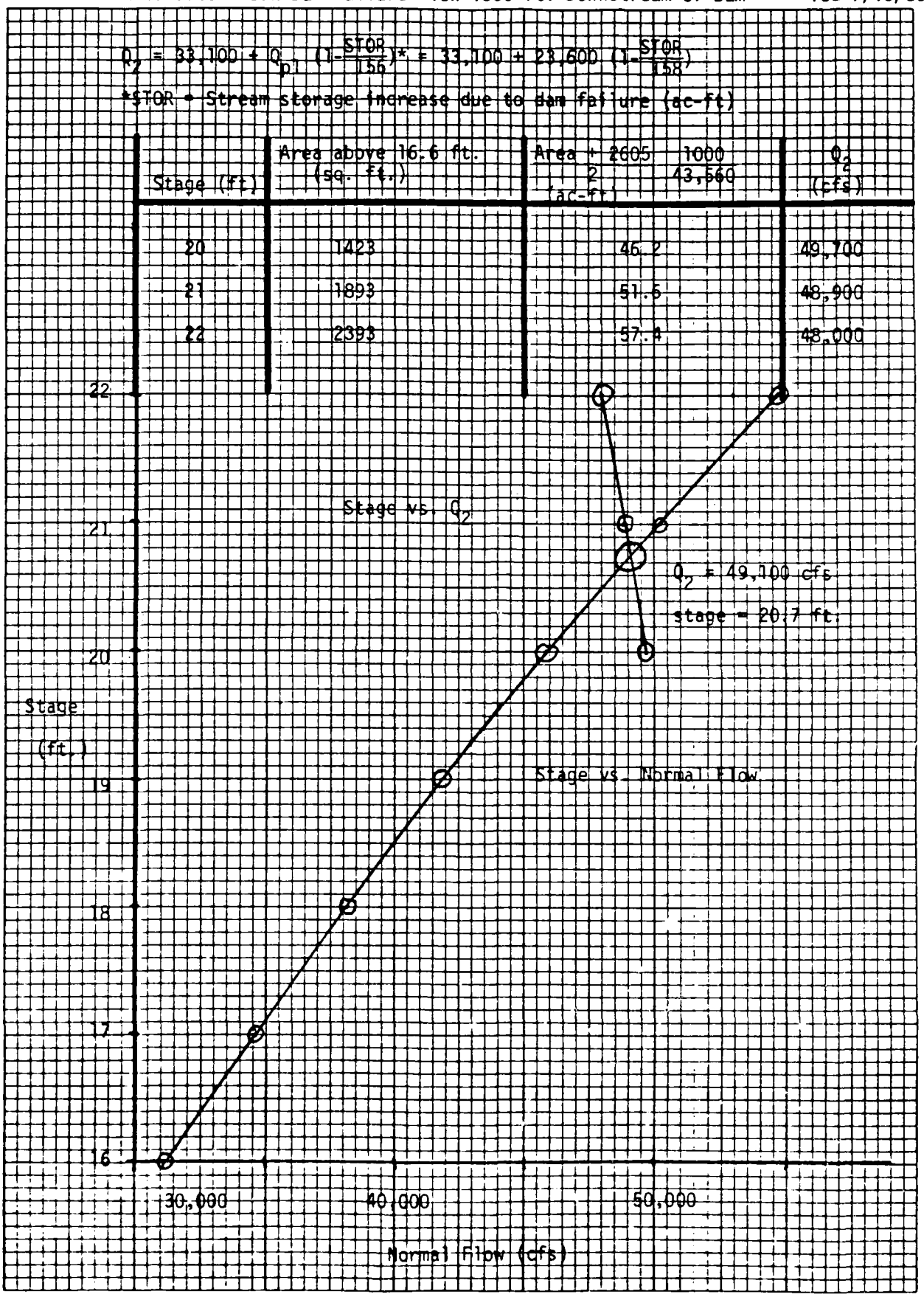
LOWER DAM
TCG 7/15/80

Attenuated Peak Dam Failure Flow 1000 ft. Downstream of Dam

$Q_2 = 33,100 + Q_{p1}\left(1-\frac{STOR}{156}\right)^* = 33,100 + 23,600\left(1-\frac{STOR}{158}\right)$

*STOR = Stream storage increase due to dam failure (ac-ft)

Stage (Ft)	Area above 16.6 ft. (sq. ft.)	Area + 2605 / 2 × 1000 / 43,560 (ac-ft)	Q_2 (cfs)
20	1423	45.2	49,700
21	1893	51.5	48,900
22	2393	57.4	48,000



AD-A156 148 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS LOWER DAM (NH 00129)..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV AUG 80

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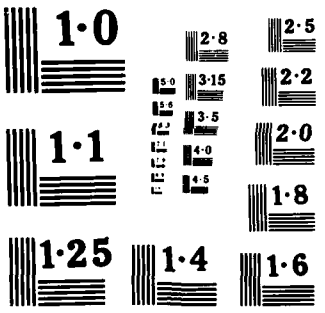
8-85
DTIC


1·0
1·1
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2·8
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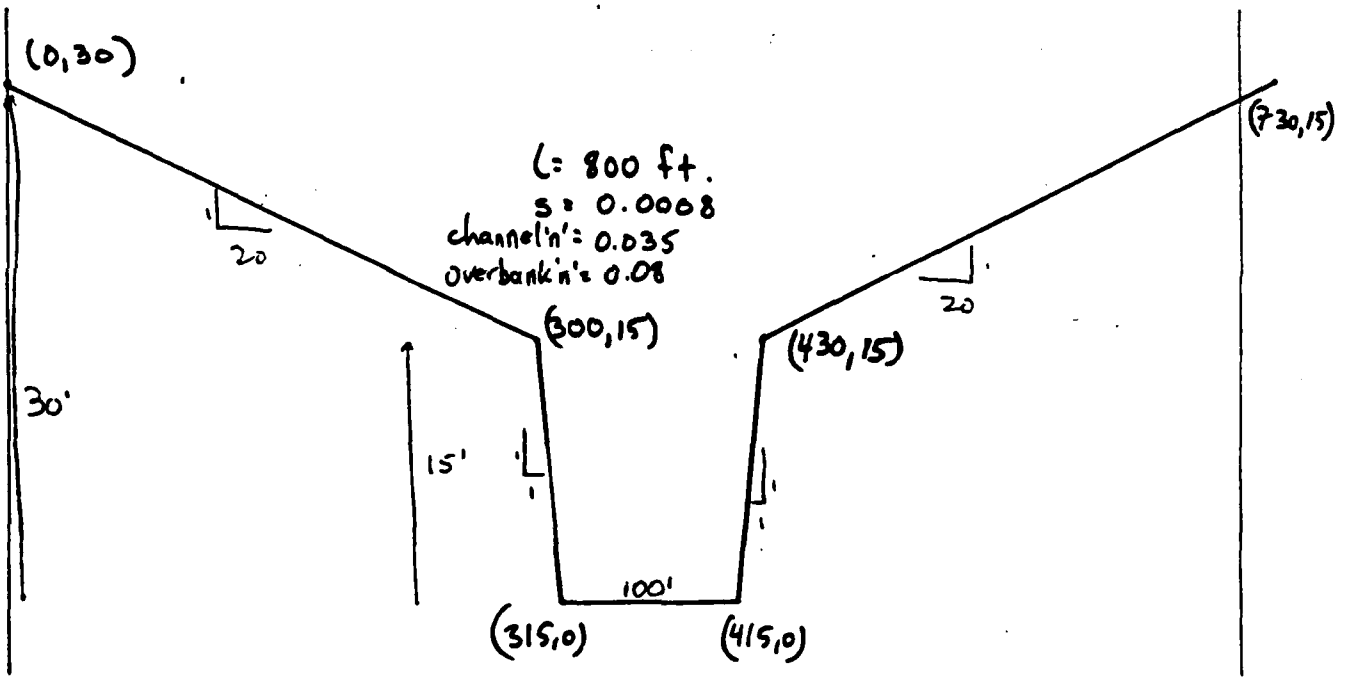
2·2
2·0
1·8
1·4
1·6

about seven feet. The other two houses, also about ½ way down, would go from 0-1 feet of flooding to 5-6 feet. Other houses would experience minor flooding, and Vermont 102 would probably receive severe damage. There would be a serious threat of loss of life in this reach.

For the next 800 feet, to just downstream of the Route 114 bridge, the river is somewhat narrower, and still between high banks. The cross-section given below, based on field notes and USGS topo information, is typical.



The stage-normal flow relationship for this reach is given on the next page. The pre-failure flow of 33,100 cfs would yield a stage of 25.7 feet. The peak dam failure flow of 49,100 cfs would give a stage of about 30.4 feet at the upstream end of this reach; large because of the constricted channel. The flow area would be about 3050 sq. ft., above the pre-failure flow area. The attenuation due to storage in this reach is calculated on page D- . The attenuated peak dam failure flow at the downstream

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.00	1.0	101.0	102.8	1.0	99.8	120.2
2.00	2.0	204.0	105.7	1.9	316.3	380.9
3.00	3.0	309.0	108.5	2.8	620.9	747.6
4.00	4.0	416.0	111.3	3.7	1001.8	1206.3
5.00	5.0	525.0	114.1	4.6	1452.0	1748.5
6.00	6.0	636.0	117.0	5.4	1966.6	2368.1
7.00	7.0	749.0	119.8	6.3	2542.0	3061.0
8.00	8.0	864.0	122.6	7.0	3175.4	3823.7
9.00	9.0	981.0	125.5	7.8	3864.8	4653.9
10.00	10.0	1100.0	128.3	8.6	4608.3	5549.2
11.00	11.0	1221.0	131.1	9.3	5404.6	6508.2
12.00	12.0	1344.0	133.9	10.0	6252.6	7529.3
13.00	13.0	1469.0	136.8	10.7	7151.2	8611.4
14.00	14.0	1596.0	139.6	11.4	8099.8	9753.7
15.00	15.0	1725.0	142.4	12.1	9097.6	10955.2
16.00	16.0	1875.0	182.5	10.3	8862.1	12372.2
17.00	17.0	2065.0	222.5	9.3	9119.0	13885.5
18.00	18.0	2295.0	262.6	8.7	9738.0	15511.3
19.00	19.0	2565.0	302.6	8.5	10663.0	17263.0
20.00	20.0	2875.0	342.7	8.4	11870.7	19152.2
21.00	21.0	3225.0	382.7	8.4	13354.5	21189.6
22.00	22.0	3615.0	422.8	8.6	15116.2	23385.4
23.00	23.0	4045.0	462.8	8.7	17162.8	25749.0
24.00	24.0	4515.0	502.9	9.0	19504.1	28289.6
25.00	25.0	5025.0	542.9	9.3	22151.5	31015.9
26.00	26.0	5575.0	583.0	9.6	25117.6	33936.4
27.00	27.0	6165.0	623.0	9.9	28415.4	37059.1
28.00	28.0	6795.0	663.1	10.2	32058.5	40392.1
29.00	29.0	7465.0	703.1	10.6	36060.4	43943.1
30.00	30.0	8175.0	743.2	11.0	40434.8	47719.7

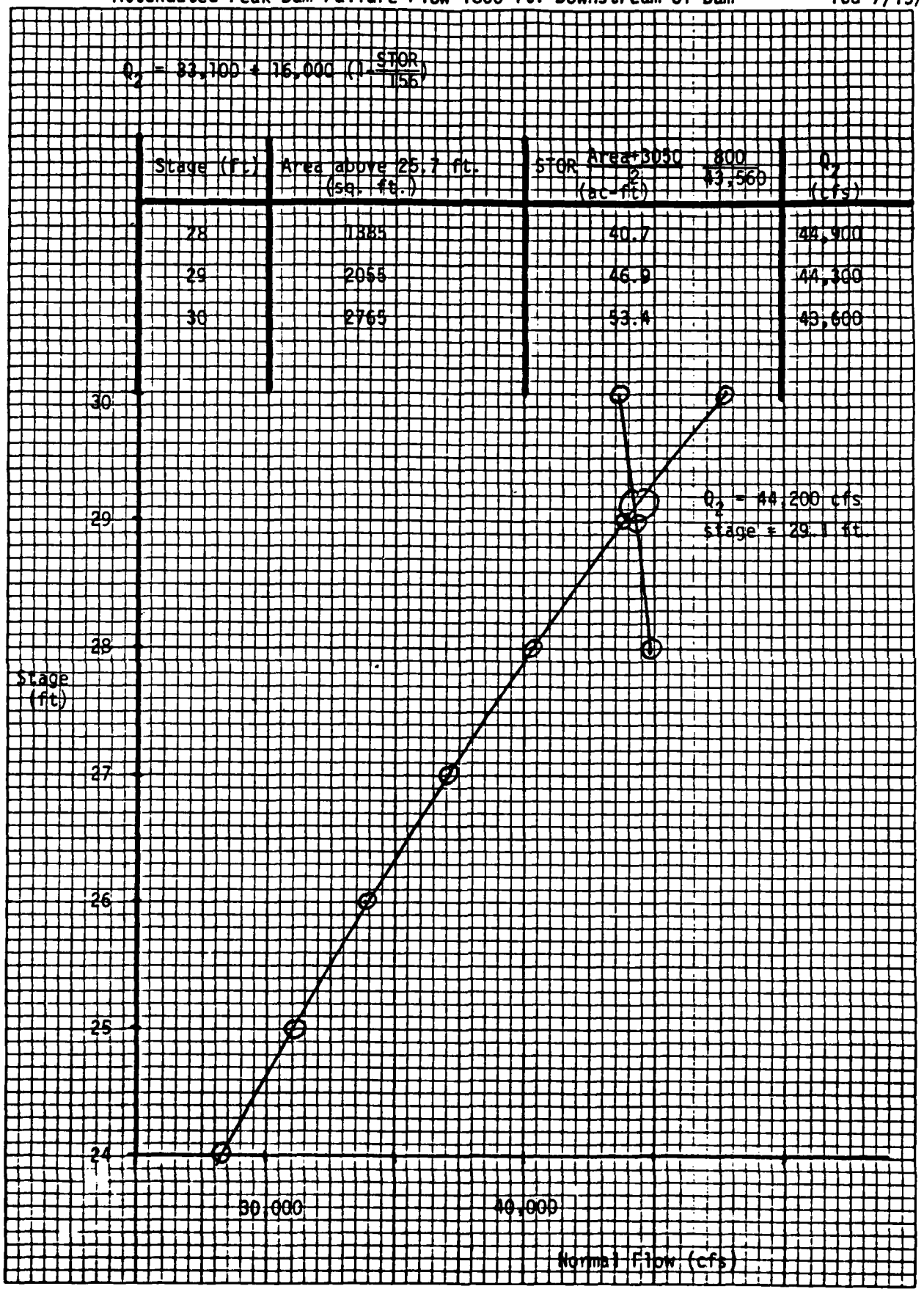
STAGE VS. NORMAL FLOW - 1000 TO 1800 FEET DOWNSTREAM OF DAM

LOWER DAM
TCG 7/15/80

Attenuated Peak Dam Failure Flow 1800 ft. Downstream of Dam

$$Q_2 = 33{,}100 + 16{,}000\left(1-\frac{STOR}{156}\right)$$

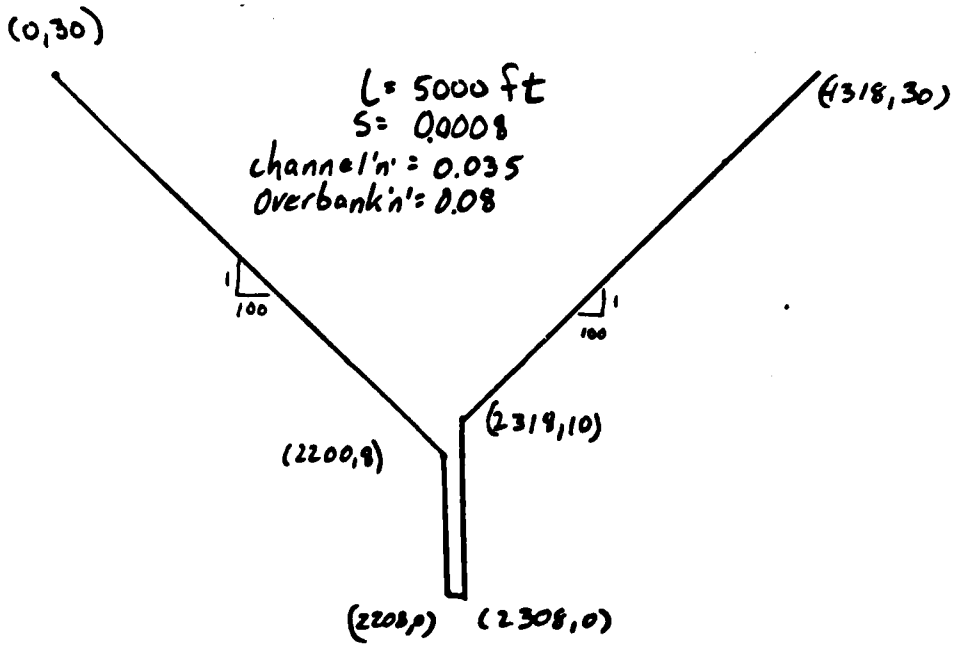
Stage (ft.)	Area above 25.7 ft. (sq. ft.)	$STOR \frac{Area+3050}{2}\frac{800}{43{,}560}$ (ac-ft)	Q_2 (cfs)
28	1385	40.7	44,900
29	2055	46.9	44,300
30	2765	53.4	43,600



end of the reach would be 44,200 cfs, with a stage of 29.1 feet.

This reach contains a great many houses on both sides of the stream, most 25-30 feet above the river. At the downstream end of the reach is the Route 114 bridge, which has a 15 foot by 75 foot opening. Just upstream of the bridge is a store about 15 feet above the stream. Just downstream of the bridge are two houses about 15 feet up. The bridge and the low houses and store would all be severely damaged or destroyed by pre-failure flows. Numerous (5-10) other structures would be threatened by the failure flood wave with its 4-5 foot increase to flooding and there would be danger of loss of life.

About 100 feet downstream of the Route 114 Bridge, the Connecticut River widens out as represented by this typical cross section (from USGS topo and field notes):



LOWER DAM

TCG
7/15/80

The stage-normal flow relationship for this reach is given on the next page.

The pre-failure flow of 33,100 cfs would create a stage of 19.0 feet in this reach. The peak dam failure outflow of 44,200 cfs would increase stage by 1.7 feet to 20.7 feet at the upstream end of the reach.

Development in the 2000 feet downstream of the Route 114 Bridge includes 2-4 houses 12 feet above the stream and another 10-15 less than 20 feet up. The failure of Lower Dam would increase existing flooding at these houses by 1-2 feet. This would cause serious damage, but probably not present a threat of loss of life.

The downstream impacts of the failure of Lower Dam with the water surface at the top of the right abutment are summarized on the chart on page D-23.

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.00	1.0	101.0	102.8	1.0	99.8	120.2
2.00	2.0	204.0	105.7	1.9	316.3	380.9
3.00	3.0	309.0	108.5	2.8	620.9	747.6
4.00	4.0	416.0	111.3	3.7	1001.8	1206.3
5.00	5.0	525.0	114.1	4.6	1452.0	1748.5
6.00	6.0	636.0	117.0	5.4	1966.6	2368.1
7.00	7.0	749.0	119.8	6.3	2542.0	3061.0
8.00	8.0	864.0	122.6	7.0	3175.4	3823.7
9.00	9.0	1030.5	224.0	4.6	2850.1	4701.8
10.00	10.0	1298.0	325.5	4.0	3264.3	5720.6
11.00	11.0	1716.0	525.5	3.3	3777.1	6983.9
12.00	12.0	2334.0	725.5	3.2	5086.5	8542.1
13.00	13.0	3152.0	925.5	3.4	7135.0	10470.0
14.00	14.0	4170.0	1125.5	3.7	9984.6	12832.1
15.00	15.0	5388.0	1325.5	4.1	13723.3	15687.2
16.00	16.0	6806.0	1525.5	4.5	18444.9	19090.0
17.00	17.0	8424.0	1725.5	4.9	24242.8	23092.2
18.00	18.0	10242.0	1925.5	5.3	31208.6	27743.0
19.00	19.0	12260.0	2125.6	5.8	39431.0	33089.5
20.00	20.0	14478.0	2325.6	6.2	48996.4	39177.3
21.00	21.0	16896.0	2525.6	6.7	59988.6	46050.4
22.00	22.0	19514.0	2725.6	7.2	72489.2	53751.5
23.00	23.0	22332.0	2925.6	7.6	86577.7	62322.1
24.00	24.0	25350.0	3125.6	8.1	102331.7	71802.8
25.00	25.0	28568.0	3325.6	8.6	119827.0	82233.3
26.00	26.0	31986.0	3525.6	9.1	139137.9	93652.2
27.00	27.0	35604.0	3725.6	9.6	160337.2	106097.5
28.00	28.0	39422.0	3925.6	10.0	183496.2	119606.4

Stage Vs. Normal Flow d/s of Route 114 Bridge

Downstream Impact of the Failure of Lower Dam

	Location & Number (see map)	Distance Downstream of dam (ft)	# of Structures	Level Above Stream (ft)	Flow and Stage Before Failure	Flow and Stage After Failure	Comments Comments
	just below dam	-	-	-	33,100 cfs 16.6 ft.	56,700 cfs 22.4 ft.	
	low houses in first reach	500	1 house 2 houses	14.5 16	33,100 cfs 16.6 ft.	52,900 cfs 21.6 ft.	Danger of loss of life
	other houses in first reach	200-1000	3-5 houses	20+	33,100 cfs 16.6 ft.	49,100 to 56,700 cfs 20.7-22.4 ft.	Flood damage, slight danger of loss of life
1	power station	1000	1	12	33,100 cfs 16.6 ft.	49,100 cfs 20.7 ft.	
	houses along second reach	1000-1800	5-10	25-30	33,100 cfs 25.7 ft.	44,200 to 49,100 cfs 29.1-30.4 ft.	Damage and danger of loss of life
2	Route 114 Bridge	1700	1 store 2 houses 1 bridge	15 15 15	33,100 cfs	45,000 cfs	Probably no additional damage due to dam failure
	houses below 114	1800-3800	2-4 houses 5-10 houses	12 12-20	33,100 cfs 19.0 ft.	<44,200 cfs <20.7 ft.	Incremental flood damage. Only slight chance of loss of life here.

LOWER DAM

TCG
7/16/80

Test Flood Analysis

Size Classification: SMALL (Storage between 50 and 100 ac-ft.; height less than 40 ft.)

Hazard Classification: HIGH

The failure of Lower Dam with the water surface prior to failure at the right abutment of the dam, would cause severe flooding and threaten loss of life in the towns of Canaan, Vermont and West Stewartston, New Hampshire immediately downstream. Damage to Vermont State Highway 102 would also result. Failure with the river at lower stages could cause damage to a penstock and hydro power station as well as the Route 114 Bridge across the river, which would already be flooded by pre-failure flows at high stages on the river.

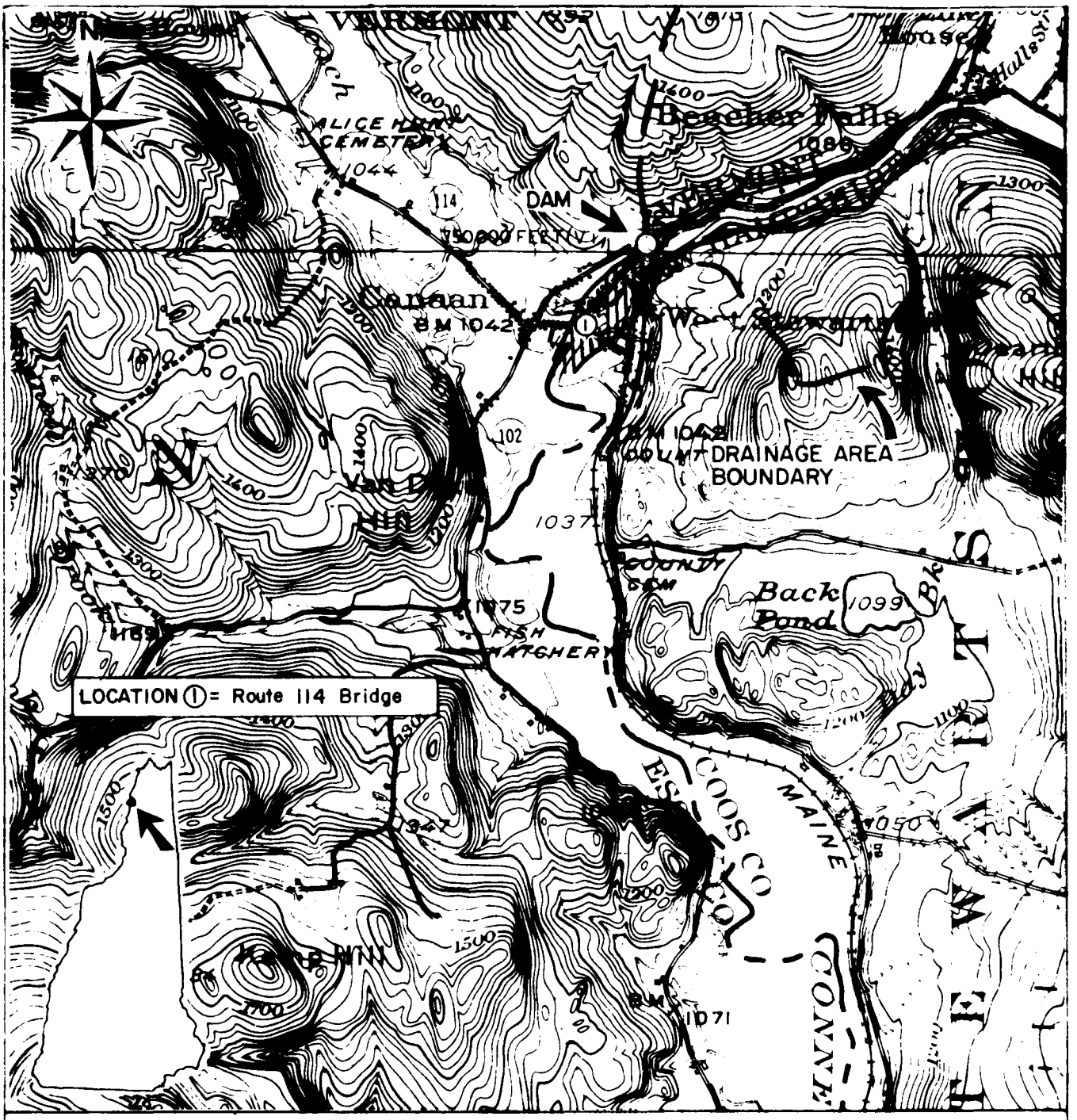
The appropriate Test Flood for a dam classified as SMALL in size with a HIGH hazard potential would be between one-half the probable maximum flood (PMF) and the PMF. Since the size of the dam is at the lower end of the SMALL category, one-half the PMF is the appropriate Test Flood.

The large amount of storage in the Connecticut Lakes and Lake Francis upstream of the dam makes the "Maximum Flood Peak Flow Rates" for New England inappropriate for this situation. Given the size of the storm of record in this area, and the general relationship between the storm of record and the PMF for the region, a peak test flood discharge (one-half PMF) of about 160 csm would be appropriate.

Peak test flood inflow = 160 csm (362 sq. mi.) = 57,920 cfs. The attenuation of the test flood due to storage in the small reservoir behind Lower Dam itself would be negligible.

The peak test flood outflow is thus 57,920 cfs, with a peak stage of about h = 29.1, 1069.1 ft. msl. This is 17.6 ft. above the principal spillway

crest, 5.1 ft. above the right abutment, and 4.1 ft. above the left abutment. The peak test flood outflow is $\frac{57,920}{33,100}$ = 175% of the spillway capacity with the water surface at the top of the right abutment.



- SCALE -

1/4 1/2 1 (MILE)

FROM USGS AVERILL, VT. - N.H. QUADRANGLE MAP

APPROXIMATE LIMIT OF FLOODING IMPACTS FOR THE FIRST 1800 FT D/S OF THE DAM

GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

US ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

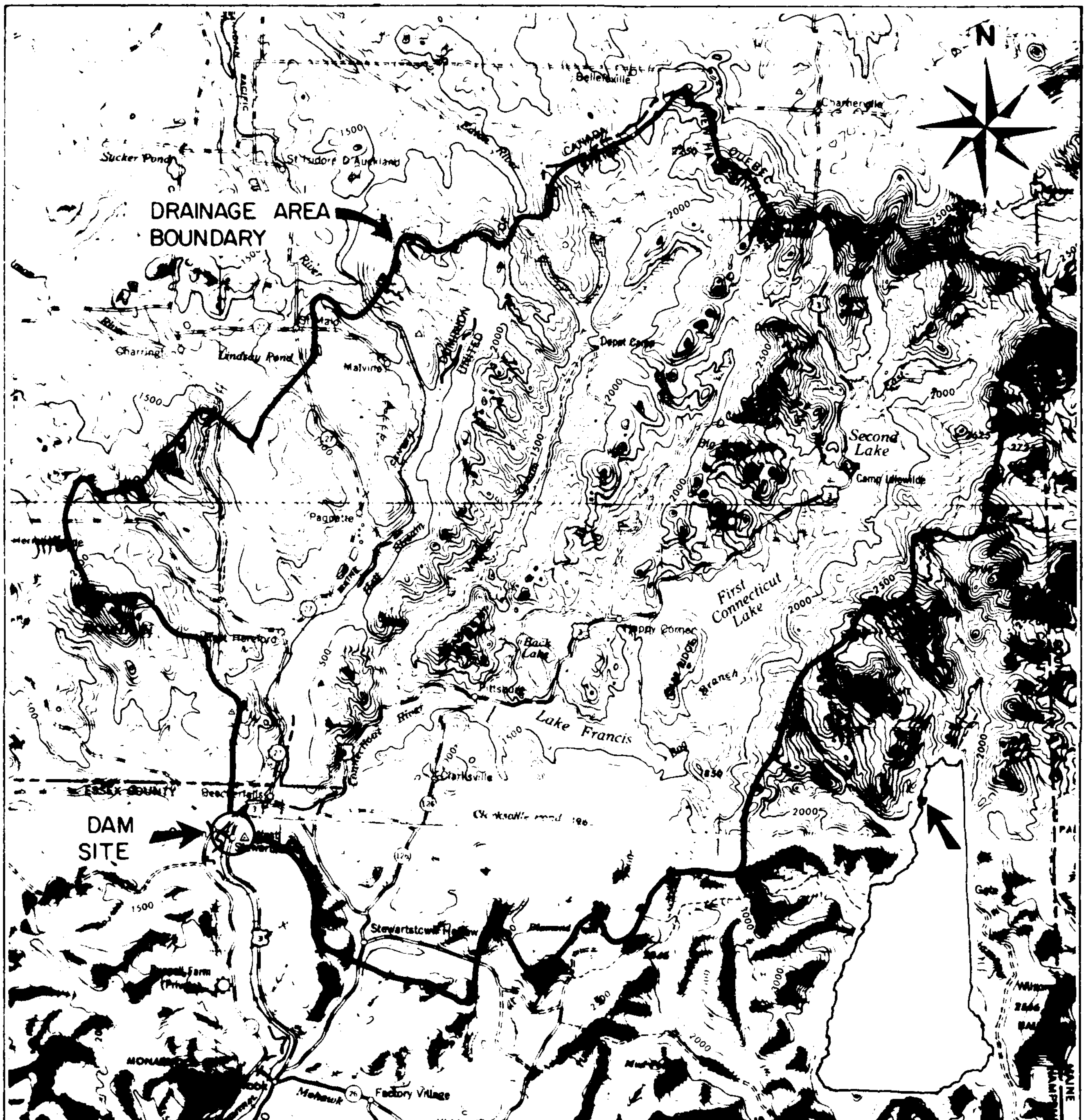
LOCATION AND DOWNSTREAM HAZARD MAP

FILE No 2605

LOWER DAM — WEST STEWARTSTOWN, NEW HAMPSHIRE

SCALE AS NOTED

DATE AUGUST 1980



-SCALE-
0 2 4 8 (MILES)

FROM

GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

US ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DRAINAGE AREA MAP

FILE No 2605

LOWER DAM

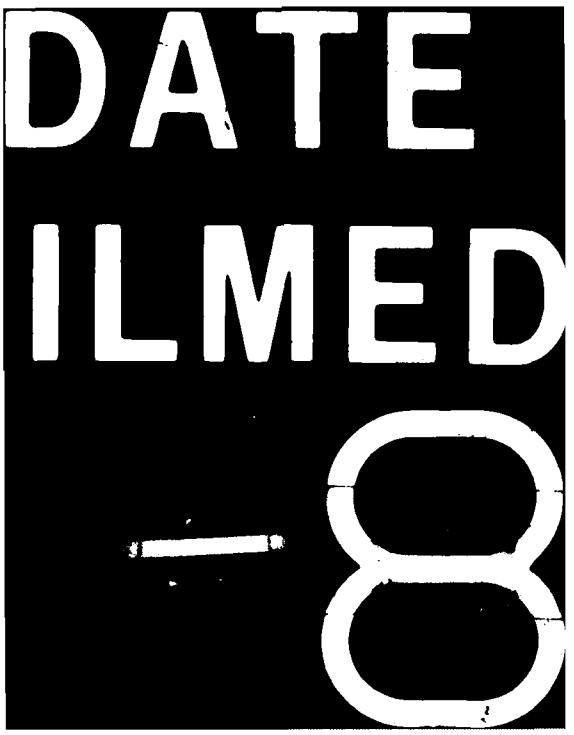
WEST STEWARTSTOWN, NEW HAMPSHIRE

SCALE AS SHOWN
DATE AUGUST 1980

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME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-8